VOLUME 4, NO. 4 OCTOBER 1949

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APPLICATION OF SIMPLE CONSERVATION AND LAND USE PRACTICES IN CHINA ..... J. LOSSING BUCK

THE VALUE OF CROP ROTATIONS FOR SOIL AND WATER CONSERVATION ..... R. E. UHLAND

APPLICATION OF STRIP CROPPING AND CONTOUR CULTIVATION IN THE NORTHEAST ..... JOHN P. JONES

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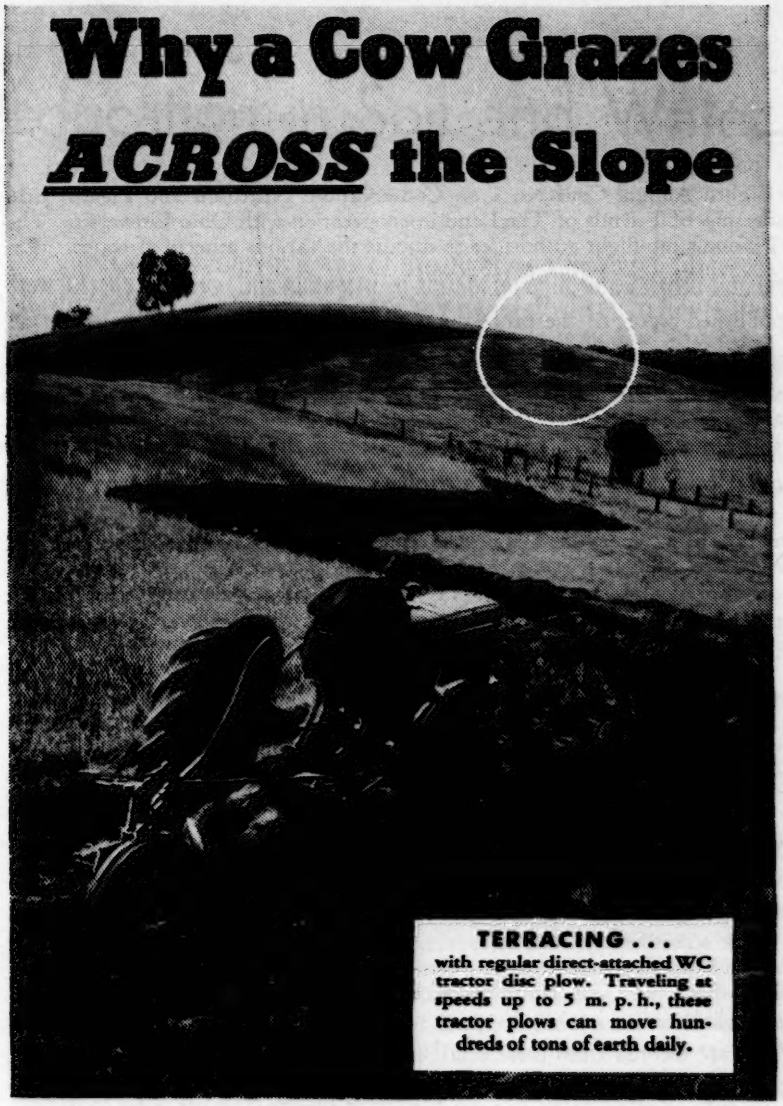

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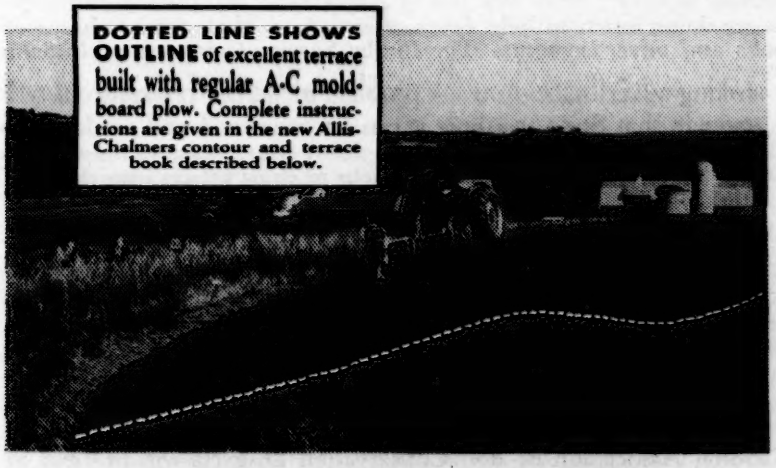

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From the Editor—

Water was the central theme of the Eighth Annual Conference on Conservation, Nutrition and Health held at Athens, Ohio, last June, under the leadership of Friends of The Land in cooperation with Ohio University. The conference brought together many of the Nation's top-flight authorities to discuss the various aspects of water. Watershed management, quality of water, rural and urban water supplies, drainage, irrigation and pollution control were some of the many subjects presented. A published report of the proceedings of the conference will be issued at an early date.

"Facts and Theory About China's Land" is the subject of a very fine article by Dr. J. Lossing Buck in the October issue of "Foreign Affairs." Persons interested in the well-being of China will want to read the article because it is realistic and thought provoking. Dr. Buck points out that "China is capable of feeding herself" provided modern methods of agricultural production are used.

William Vogt recently called our attention to a paper that was presented to the Chicago Literary Club in April, 1920, by Arthur J. Mason, entitled *"Is the United States a Permanent Country Like North Europe?"* Mr. Mason told the Literary Club that soil erosion and improper use of the land was depleting the agricultural resources of this country. This incident occurred 29 years ago—several years before the inception of the conservation movement. Another article worthy of reading is entitled *"Soil Productivity and The Potential Food Supply of the United States"* by Richard Bradfield of Cornell University.

A recent report from A. C. Watson, Secretary of the Soil Conservation Society of America, shows that the JOURNAL *now goes to every state in the Union, the District of Columbia, Puerto Rico, Hawaii and Alaska. Thirty-two foreign countries are also listed.*

Some time ago, a Superior Service Award was presented by the U. S. Department of Agriculture to the Division of Watershed Protection and Management of the Southeastern Forest Experiment Station at the Coweeta Laboratory in the Western North Carolina mountains, for its work in charting water balances on a series of small independent drainage areas of 200 acres or less. With scientific controls, measuring precipitation on the land and then the exact quantity of water "produced" by the land under timber, without timber, under grazing conditions, logging conditions, mountain farming conditions, and others, the experiments produce records directly related to years, seasons, months, and even minutes. It is thus possible to trace what happens to rainfall from individual storms and why, under different forms of land use. Accurate records from these small areas wil be particularly useful in establishing basic principles that govern watershed storage in relation to seasonal water yields. The results have wide application in the administration of municipal and industrial watersheds.

Industry and other related groups are doing much to help focus attention on the various phases of conservation, through pamphlets, books and advertisements. The Public Service Company of Indiana recently prepared and released a very striking advertisement on the problem of water. It points out and emphasizes what has happened to the water in that State and how it can be conserved and made available for useful purposes. The advertisement is supported by statements from four outstanding agricultural leaders. Advertisements of this type have educational value and help to draw others into the field that may be concerned in one way or another.

The *"Efficient Use of Fertilizers"* is the title of a new FAO publication which reports world experience in the best use of manures and fertilizers for increased crop production. It is the first publication of its kind in which fertilizer practices in thirty countries are referred to in the text. The book is edited by Dr. Vladimir Ignatoeff, Soil Fertility Specialist of FAO. Another publication of interest is *"Weed Control in Small Ponds,"* published by the Virginia Agricultural Experiment Station. This bulletin is one of the first of its kind to be issued. It will undoubtedly fill a real need among persons concerned with the weed problem in farm ponds.

The 1950 Convention of the National Association of Soil Conservation Districts will be held in Atlanta, Georgia, February 28 to March 2. Reports indicate that this meeting will not only be outstanding but also important because of the down-to-earth conservation policies to be enunciated.

Education in Soil and Water Conservation

EDWIN C. HOLLINGER

Conservation as a way of life involves a new and different concept for most of us. Our training and habits of thinking have not generally been in line with conservation. Our physical sciences, our history and other social sciences, and our fiction and other literature reflect the idea of conquest and subjugation of the land and exploiting and often wasting our resources.

Our whole social, economic, educational, and governmental structures were developed with little or no regard for conservation. Some of the laws, the taxation, the literature, the unwritten traditions, and in some cases the land tenure pattern and public policies have offered resistance to full conservation. To overcome these influences we must make known conservation as a worldwide human problem and a challenge to all of society and to each of its individuals.

Education is our oldest profession. Before the Christian Era, procedures, methods, and techniques in education had been developed that have their practical use today. Nearly every person must cultivate some of the techniques of education. However, in our day, education has become highly specialized. Few of the scientists who are the inventors, discoverers, and technicians have the specialized training or the inclination for educating. Usually the educators must interpret the scientist's material and help in putting it into practical use.

Soil Conservation is one of our newest sciences and yet one of the oldest. Some of the principles of conservation were taught and observed in ancient times. However, it was only in recent years that the collection of scientific facts and principles in soil conservation has caused it to become recognized as a definite science. Like other sciences, the conservation of soil and water resources is interrelated with various other physical, biological, and social sciences. To accomplish the most in soil conservation education we must enlist the help of educators, furnish them information regarding the conservation program and encourage their work in conservation education.

As defined by some recent dictionaries and encyclopedias, "*Education is all the processes consciously adopted for realizing in individuals the ideals which are approved by the race or by the particular group.*" The English philosopher, Herbert Spencer, said "*To prepare us for complete living is the function education has to discharge.*" Education in a soil conservation program may logically be defined as, "*all the processes adopted to adjust the attitudes, develop the understanding, increase the abilities, and stimulate action in accomplishing and maintaining conservation.*"

The beginning of conservation must generally be a change of attitudes. The change of attitude toward soil conservation often requires an "about face" from habits of exploitative thinking and action to that of conservation in the interest of humanity. Becoming a real conservationist requires much study, observation, and profiting by our own experiences and those of others. Even after we think the conservation habits are fixed we find reversions to old habits when the temptations of immediate convenience and increased returns face us.

Resources for Conservation Education

Within each community there are agencies and organizations whose purposes are largely or at least partly educational. Of first importance, of course, are the homes. Add to these, the schools, the churches, fraternal organizations, womens clubs, agricultural conservation associations, farm bureaus, granges, farmers' unions, farmers' cooperative associations, irrigation and drainage organizations, and other farm, ranch, and home organizations, service and civic clubs, financial and commercial organizations, 4-H Clubs, Future Farmers, and other youth groups. Should not every one of them have an active interest in conservation as a way of community, national, and international life?

A count some time ago showed over 150 different

Edwin C. Hollinger is the author of this very fine article. It contains not only a brief review of known educational resources and techniques, but opens wide the door and presents new problems and approaches that conservationists, educators and others must eventually solve. Mr. Hollinger is a cooperative employee of the Agricultural Extension Service and the Soil Conservation Service. His headquarters are in Los Angeles, California.—EDITOR.

organizations present in almost every state that can help, and in some cases are helping with soil and water conservation and whose efforts involve some participation in the educational phases of the work. Every community also has educators who know the methods of education, and are potential conservationists. You find them among the public school teachers, the preachers, the leaders in farm and home organizations, business and various other groups. They can help select and adapt the information and apply the methods to meet the current needs of the program. County extension agents can help develop and carry on a system of conservation education.

Soil conservation district governing bodies are vitally concerned with soil and water conservation education adapted to the needs of their districts. They are also concerned with all phases of conservation operations to carry the education into action on the land and to maintain and improve the conservation work. They can sponsor or cooperate with a system of conservation education designed to facilitate the work of all who can help in conservation education and operations. A good committee on soil conservation education can go a long way in developing and carrying out plans for coordinated educational work.

There are many state and federal agencies that have a part in soil and water conservation. The American Bankers' Association has provided for local bankers a manual for their reference in cooperating with soil conservation districts, and is emphasizing in its literature the importance of soil conservation to the local banker. The American Agricultural Editors' Association has set in motion a plan for a united nation-wide effort in focusing attention on the need for conservation.

The programs of schools and youth organizations can be designed to train young people to understand the importance of soil and water conservation, to participate in conservation activities, and to be prepared to take their part in completing, maintaining and improving the conservation job. Boy and Girl Scouts, Future Farmers and Homemakers, Science Clubs, Religious and Social organizations include conservation training in their programs. The National 4-H Club Soil Conservation Program fostered by the Federal and State Extension Services provides this type of training.

State and county school systems are moving towards providing materials and guides for teaching soil conservation in grade and high schools. Teacher training institutions are training teachers for teaching conservation. Vocational agricultural teachers have been supplied teaching guides in soil conservation by the Federal Office of Education. In many of the states these guides have been supplemented by a state guide for vocational training in soil and water conservation.

Local Conservation Leaders

Local leaders have an important part in soil and water conservation education. During the expansion and improvement of agriculture in recent decades, the emergency agricultural adjustment, and the war and postwar production, local leaders, project leaders, and committeemen have furnished much of the power that got the jobs done. Such leaders have largely been the force that brought about recognition by farmers of the conservation problems and the organization of over 2000 soil conservation districts in the United States that include over three fourths of the farms and ranches. They now can provide a real force for progress in applying conservation on the land.

Each year about one million volunteer local leaders help with the Extension education in agriculture and home improvement. In these activities the jobs of the leaders have been defined. The jobs have involved progressive steps that are rather simple. The conservation educational program can be greatly facilitated by defining the jobs of conservation leaders, furnishing them adequate information and working materials and helping them with community and neighborhood educational activities.

The local Conservation leaders are most effective in working with neighborhood groups. Man is a social being. He is so constituted that he naturally neighbors and works in groups. He depends on leaders to break the trails and lead the way. The spread of conservation farm planning, and conservation practices often follows lines of neighborly and kinship contacts. The Soil Conservation Service emphasizes work with neighborhood groups in planning, applying and maintaining conservation work on the land. Plans for conservation education are designed to take advantage of these natural ties.

Informational Services

Information is essential to equip all who are concerned in conservation education to do their parts. Many methods of disseminating this information are at hand. Local radio stations usually offer opportunities for many different individuals and groups who are actively working in soil and water conservation to participate in extending conservation information to others. Television is proving an effective means of conservation teaching. As time goes on more communities are receiving the services of television.

A regular soil conservation column in local newspapers

is a good information medium. In addition to news, such columns often supply subject matter that is not available in other published form. Bulletin boards at community and neighborhood centers and circular letters have been used to advantage, especially where newspaper services are limited.

In many cases a local high school or other educational organization gets out a soil conservation news letter in cooperation with soil conservation district governing bodies. Often a local business firm or group of business men or commercial organization has advertisements in the publication which pay for the printing and mailing. An example of such a bulletin that is widely recognized as a practical, readable bulletin adapted to the interests and education of the farmers in the area is *"The Soil Saver"* in the Thomas Jefferson Soil Conservation District in Virginia. Six banks in the district pay the cost of printing and mailing and receive recognition in each issue for their contribution. A committee composed of district supervisors, county extension agents and district conservationists works with a division of the University of Virginia in preparing the material.

Much can be done by interesting and informing the professional writers—the local neighborhood and community news reporters, the feature article and editorial writers. They are looking for live, interesting material such as a soil conservation program provides.

More books, bulletins, magazines and farm papers are supplying material that is helpful in soil conservation education. Many of the publications are clear, direct, easy to read and understand and well illustrated. Specialists in the agricultural colleges and in the U. S. Department of Agriculture are preparing such materials. Many of the newer bulletins and circulars that deal with production of crops and livestock now carry appropriate information on conservation as applied to the respective enterprises. As the older subject matter publications are revised they will greatly help in supplying farmers and others with needed conservation information. Commercial organizations are printing and distributing helpful materials on conservation. Many soil conservation districts have had bulletins printed to supplement and adapt material from other sources to meet the needs in their districts.

The available literature on soil and water conservation is still limited and many times more is needed. But a good selection of helpful literature can be found in the offices of the county extension agents and district conservationists. A surprising amount is getting into public libraries. A real contribution will be made when librarians generally become conservation conscious and make available to library patrons a wide selection of conservation literature.

Ideas of conservation are appearing in our current popular reading some of which is going to be enduring literature. They are also beginning to affect our art, our poetry and our songs. But these developments have only begun. As you read newspapers and magazines, even in issues that contain good articles on soil conservation, you find other articles that inadvertently reflect the ideas of exploitation of land resources. It may take a long time to overcome these habits.

We can make good use of the available paintings, photographs, poetry, and songs that develop an appreciation of natural land resources—trees, grass, wildlife, and clear sparkling streams. The conservation essay, poster, and photographic contests help develop the individuals. Self education in soil conservation may be stimulated through such contests and systematic recognition of conservation accomplishments. Contests can intensify the interest of individuals in reading, thinking, observation, and discussion of conservation that is important in developing the understanding and the habits of conservation. And here and there gems of conservation literature come from such activities.

Education Into Action

Whatever other features an educational program may include, *a network of demonstration farms is a forceful part of the conservation education program. There should be two or three in each community, and so far as possible, one in every neighborhood.* The farm conservation demonstrations should be as complete and practical for the area as possible. They should be used as places for field observation meetings and stops on farm tours. The experiences of these demonstrators can be emphasized in news items, and in meetings of many kinds. Pictures of outstanding pieces of work can be used in many ways. The demonstration can be improved from year to year and other demonstrations may be added as the conservation work spreads over the farms in the area. *District governing bodies can well encourage district cooperators to work with the Extension Service in developing farm-home plans as additions or supplements to the farm conservation plan that farmers develop in soil conservation districts with the help of Soil Conservation Service technicians. The full benefit of conservation is not realized until it is correlated with farm production, and farm, home and community improvement.*

To adopt and maintain conservation farming and ranching it is necessary for the operators to learn many new skills and techniques as well as to have technical and other types of services available for them. Much of

(*Continued on page* 145)

Application of Simple Conservation and Land Use Practices in China

J. LOSSING BUCK

The Chinese conception of conservation is the need for water to produce crops. 46 percent of the cultivated area is irrigated. Because of this need the farmers of China have, over a period of thousands of years, developed many effective simple conservation and good soil-use practices.

Dr. Buck discusses how water is obtained through stream diversion, canals, ponds and other means for irrigation purposes. Methods relating to the construction of terraces for erosion control, tree planting, dyking for flood control and the application of agronomic practices, are also covered.

CHINA IS OFTEN CITED as a horrible example of soil erosion. Let us this afternoon consider the other side of the picture—China as an example of simple conservation and good soil-use practices applied for centuries over a great area of that country's farmlands. For China is an old country. Its lands have been used for thousands of years. Some land has been badly used and seriously exploited. But there is another aspect—the invention and application of good practices, practices having the greatness of simplicity, which have been used for thousands of years over millions of hectares in China. These simple practices are those which every farmer or farm community can use with local resources. They are based on a need for conservation and good use of land, a knowledge of their usefulness, and a desire to make them a part of the farming system. They are as much a part of Chinese farming as knowing how to plant seeds at their proper depth.

The greatest Chinese conception of conservation is the need for and importance of water to crop production. China uses water in farming to a greater extent than any other people with a similar-sized territory. Land-use surveys indicate that 46 percent of China's cultivated area is irrigated, and, strange as it may seem, the largest proportion of this irrigation is in the humid regions. To grow rice you must have water. With sufficient water, the Chinese find that rice provides greater food production per unit of land than any other crop. For this reason, rice is the chief crop in the regions where water, soil and climate are favorable. The source of this water varies in different areas. Aside from direct rainfall on the fields, water is obtained from the diversion of streams, from canals connected with streams and rivers, from lagoons, from excavated ponds, and in West China from collecting rain water in rice fields through the non-growing period by refraining from planting winter crops such as wheat, barley or broad beans.

Methods of Irrigation

Diversion of streams is the greatest source of water. Small-scale stream diversions account for a much greater irrigation area than large-scale diversions. Individual farmers and communities in many parts of China divert water from mountain streams along the slopes. Canals are a typical means of water utilization in the lower Yangtze delta area, near Shanghai, where water is made available to farms by a network of canals dug by hand centuries ago. Some of the fields can be irrigated by gravity flow, but pumping is usually necessary. The traditional wooden pump made by local carpenters consists of a wooden trough with an endless chain of wooden slats moving over a cogwheel of wood. It is propelled by handles for hand pumping or by pedals for foot pumping and ranges in size from a one-man pump to a six- or eight-man pump. Similar types of pumps are also propelled by a water buffalo or by a windmill.

These pumps are used mostly for low lifts of several feet. For this purpose they have been found more efficient than centrifugal pumps. However, man and animal power are often insufficient to pump the amount of water needed by the crop at certain times. For this reason internal combustion engines have come into use as a source of power for pumping. Farmers have attached belt wheels to their wooden pumps and contractors owning engines put them on boats and ply the canals, irrigating the farmers' crops at so much per unit of land. This kind of mechanization, combining traditional with modern equipment, indicates possibilities for other conservation operations.

The canals are also a convenient farm-to-market trans-

Dr. J. Lossing Buck is chief, Land Use Branch, Agricultural Division of the Food and Agriculture Organization of the United Nations, Washington, D. C. He has been associated with the agricultural movement in China since 1915 and during that time wrote three books and conducted numerous surveys. Dr. Buck is a recognized authority on the agriculture of China. This paper was presented at the United Nations Scientific Conference on the Conservation and Utilization of Resources held at Lake Success, New York, August 17 to September 6, 1949.

Photo by W. C. Loudermilk, S.C.S.

Irrigation channel at the right showing diversion from the Ming River at the left. The cofferdam built each year to permit cleaning of the irrigation channel is just above the long bamboo bridge.

portation network throughout the Yangtze delta. Instead of using farm carts, these farmers use farm boats to transport produce from the fields to the farmstead and for taking fertilizer to the fields.

Locally the canalized area is known as the "water road" area; it is greatly favored for farming and travelling as compared with the adjacent rolling lands, known as the "dry road" area. The distinction is also reflected in higher values of land and higher rates of taxes for the "water land" than for "dry land." Where "water land" and "dry land" are close together, farmers try to have both kinds of land in order to distribute risk and assure income. Difference in productivity of land is one of the reasons for fragmented holdings in China.

Although the diversion of small streams is the most important source of irrigated water, some large diversion projects also illustrate the use of simple methods. The outstanding irrigation development of the Chengtu Plain in Szechwan Province is an example of a three-hundred-thousand-hectare project for the diversion of water by use of simple methods. The Chengtu Plain had been already settled for centuries and it suffered periodically from droughts and famines. The situation was so serious that a man named Li Bing conceived the idea of diverting water from the Min River to the Plain by cutting a channel through a small ridge and distributing the water by irrigation channels throughout the Plain. Modern hydraulic engineers credit Li Bing with having known every principle of hydraulics. As a result of his work, famines were banished forever from the Plain.

Destruction of canals by the flood waters of the Min River is prevented by maintaining the proper height of the diversion channel banks just below the intake, as spillways into forked branches of the river. Li Bing insured proper maintenance of the diversion channel by burying a large piece of iron in the channel bed at a depth to which debris had to be cleaned out each year. I saw this iron during one of the annual clearances of the diversion channel. Moreover, the banks of the diversion channel are protected by what is commonly known as bamboo sausages, consisting of long containers woven from local bamboo and filled with large cobblestones. Maintenance is carried out each year by a labor assessment from each county on the Plain, plus a water charge per unit of land. The system has been in operation for 2,000 years. It was built and is maintained without any modern equipment. Modern Chinese engineers who consider that they can improve the system find skepticism and opposition from farmers and local officials who fear that tinkering with a system which has operated satisfactorily for so many centuries might cause disaster.

The cost of the system is light in comparison with its advantages. The water charges are low and the assessment of labor each winter is not a heavy burden because it occurs during the time when farmers have little other work.

Although the chief purpose of the Chengtu Plain project was irrigation, the canal water is also used for water power to grind grain and to hull and polish rice. Big irrigation wheels propelled by the flow of water are sometimes used to lift water to higher land. Food and

hand pumps are prevalent wherever water cannot be taken to the fields by gravity. Portions of the canals are used for transportation, but no system of canal locks was developed for an overall water transportation system throughout the Plain — an omission in Li Bing's planning for the use of Min River water.

Another large irrigation project, also constructed about 2,000 years ago, was in a dry unsettled area at Ninghsia, North China, where water was diverted from the Yellow River. Little or no attention was given to the appropriate size of farms for settlers or to drainage to control the salinity of soils. Much of the farmland is now suffering from salinity, which reduces crop yields or prevents crop growth altogether. Land-use surveys show that these farmers have a lower standard of living than farmers in many other areas. By comparison the Chengtu Plain is a paradise, chiefly because it has good soils and a more adequate size of farm makes possible better standards of living.

On rolling lands out of reach of canals and streams, ponds are dug to catch rain water run-off from the surrounding area. To make certain of obtaining all possible water, minute diversion channels are dug on the higher lands leading water to the ponds. Irrigation from these ponds is by gravity to the lower fields and by pumping to nearby higher fields.

Efficient use of all these irrigation waters is a prime concern of Chinese farmers. Stone masonry is used to protect canal banks and to make locks and spillways. Seepage in farm irrigation ditches is minimized by puddling the soil in the bottom and sides of the ditches. The water is applied by flooding, furrowing and spreading.

Dyking to Prevent Flooding

Extensive dyking is another simple form of water control to prevent flooding of crop land. The whole Yangtze Flood Plain inside the main river dykes is a complete network of dykes built and maintained by village communities. During the flood season farm villagers take turns patrolling the dykes and sounding a gong whenever a break is discovered. This dyking system works well except for occasional peak floods. For instance, during the Great Flood of 1931, which inundated the lands of some 25 million farmers, practically every dyke was overtopped wtih flood waters. A similar flood occurred some 70 years previously. However, these and minor floods are not without their benefits. Farmers claim the silt enriches their land each time it is flooded. But dyking of a flood plain delays the geological process of building it higher. One might consider that, geologically speaking, the flood plain has been settled too soon.

In the wheat and millet areas of North China irrigation occurs on about 15 percent of the cultivated area. In the Great Plains portion it is largely from dug wells with a Persian wheel type of pump. In Northwest China it is chiefly from diversion of small streams. Modern knowledge of deep well drilling will undoubtedly result in a development of deep well irrigation in the Great Plain of North China, where geologists have indicated there are large underground water supplies.

Photo by W. C. Loudermilk, S.C.S.

Terracing of rice fields in the Szechwan Province, China. Extensive areas are thus terraced to grow one crop of rice a year. Winter crops are not planted because the terraces are used to collect enough rainwater and runoff to supply water for the summer crop of rice.

Photo by W. C. Loudermilk, SCS

In Western Shensi Province and also in Eastern Kansu Province on the Loess Plateau this type of terracing is common.

Terracing

A great deal of Northwest China is so rough that extensive irrigation is impossible, but the Chinese have met the situation with a large amount of terracing; stone-faced terraces and bench terraces to hold as much water as possible.

In some areas of Shansi Province, these terraces are graded and sloped toward the mountain to hold rainfall. At the center of each terrace is a carefully constructed stone-faced spillway to carry off any excess water.

In the rice region terracing is even more extensive, because rice fields must be level to hold water. This levelling with plows, shovels, and a special pronged iron leveller drawn by a water buffalo is one of the greatest aids to the conservation of both land and water.

On the eastern slopes of West China's mountains, the diversion of excess water from croplands is engineered as well as anywhere in the world. There I have seen diversion channels on steep slopes leading into a main stone-lined channel and well protected with erosion control grasses.

Special types of conservation are found also in limited areas. In the Province of Honan good soil buried during floods with sand and gravel from the Yellow River is retrieved during the winter months with simple implements by turning under the top debris and bringing the good soil to the surface. Conservation in the dry area of Northwest China may also extend to such laborious methods as the carrying of pebbles from stream beds to fields as a mulch to absorb and hold moisture in the soil.

The tremendous engineering feat of levelling rice fields, terracing fields on mountainsides in both the rice regions of South China and in the drier regions of North China, and bench terracing on less steep slopes, has taken place on nearly two-thirds of the cultivated area of China. And it was done with human and animal labor by means of simple tools like the shovel, the plow, the levelling harrow, and the hand-laying of stonework. The need and the desire for the conservation and full use of land and water have been so great that thousands of small informal community organizations and millions of enterprising individual farmers did it without any national or provincial conservation commissions and without mechanized equipment. They did this work during slack seasons. By this means they enlarged the size of their farm business without increasing the area of the farm. Even so, the job is far from complete.

Modern Developments

But the application of known methods is being extended and demonstrated in the modern version at Tien Shui, Kansu Province, Northwest China, by personnel with up-to-date training. The Tien Shui Soil and Water

Conservation Station was established in 1941 to study the conservation problems of the area and to determine through experimentation the practices best adapted to the area. The site chosen is typical of the vast region of the Upper Yellow River watershed; methods found practical in Tien Shui should be applicable over a much wider area. The technical personnel at the station consists of a civil engineer, a meteorologist, an agronomist, and foresters.

A recent report of the station's work illustrates successful practices, combining local resources and methods with knowledge obtained through modern training. It has been found that the planting of willow, black locust, hybrid poplar, tamarix, sweet clover and alfalfa on previously non-productive areas has been effective in controlling erosion and in building up soils of small flood plains through siltation. An additional advantage is gained because the woody plants provide urgently needed fuel and the sweet clover and alfalfa furnish fodder for livestock. By confining the river channel within dykes, the flat areas outside the dykes have been reclaimed through siltation by flood water allowed to pass through gates in the main channel dykes. Some of these new areas are already growing good crops. These additional lands make it possible to relocate farmers now cultivating steep mountain slopes and to provide permanent vegetative cover for the badly eroded slopes. Improvements have also been made in types of bench terraces. On the more sloping terraces, contour cultivation and improved crop rotations have been introduced. It is claimed that all the water that falls on the demonstration fields is absorbed by the soil. If similar results could be obtained over the whole of the upper Yellow Rivershed area, the amount of silt carried by the Yellow River would be reduced and floods would be minimized.

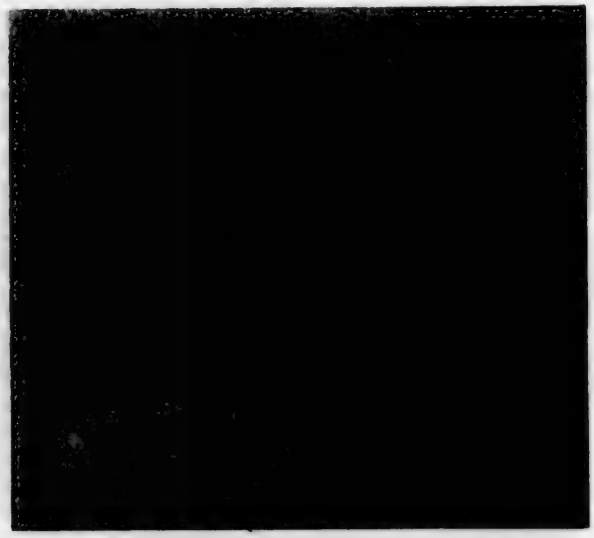

Photo by Robert L. Pendleton, Johns Hopkins University, Baltimore, Md.

Recently constructed masonry pit for night soil and other excreta. In the Memorial Forest reservation, along the Changhwa Road, west of Hangchow, China.

Agronomic Practices

The conservation picture in China does not end with man's modification of land and his control and use of water. Strictly agronomic practices also hold an important place. Production, storage and use of farm manures is a great source of plant nutrients. While the American farmer on small eastern farms has the saying, "raising hogs is like putting money in the savings bank, the profit is interest only," the Chinese farmer says, "raising hogs gives only a profit of manure for the land." Few appreciate that farms in China have a density of animal population greater than farms in a similar-sized country such as the U.S.A. Although a large proportion of these animals are for draft purposes, still they provide for a moderate rate of application of manure to the land. These farm manures, as well as human excreta, are the chief factors in maintenance of soil fertility. It is estimated that night soil itself supplies 15 percent of the plant nutrients in China, whereas in most countries it is wasted. Additional potash requirements are largely met by the ashes from crop by-products of stalks and straw, which supply most of the fuel of China. Still further plant nutrients and organic matter are obtained in Central and South China by digging muck out of canals, lagoons and ponds during the winter season and applying it to the fields as fertilizer.

In the Rice Region the growing of the legume, *Astragalus,* for plowing under or for cutting and composting with night soil is an excellent practice and an important source of organic matter. Other organic matter for rice fields in some areas is supplemented by cutting grass and weeds from nearby rolling hill lands and working this organic matter into the soils of the flooded fields.

The rotation of crops throughout China, the use of green manure crops in certain areas, and the extensive use of legume crops play an important function in maintaining soil fertility. In a land-use survey of 17,000 farms in 22 provinces, farmers reported 546 cropping systems. These crop rotations follow the essentials in providing for shallow and deep rooted crops, cultivated crops and leguminous crops.

In North China many localities have as many as 12 to 15 different crops fitted into the various rotations. This diversification lessens the risk of crop failure, utilizes plant nutrients efficiently, maintains soil conditions, distributes income over a larger part of the year, and provides good labor distribution.

Excellent control of weeds in these rotation systems

is prevalent for maximum use of moisture and plant nutrients for growing crops. Weeds are seldom allowed to go to seed in the cropped fields of China. Not only are row crops cultivated several times, but all cereal crops are hoed once or twice during the growing season. The importance of cultivation is illustrated by the saying:

"If you hoe cotton three times,
It will be white as snow;
If you hoe rice three times,
The swelling grains will burst the husks."

The farmers' understanding of rotation is evident from sayings in the countryside such as:

"Planting millet after buckwheat
Will cause the farmer's wife to weep."
"Plant millet after millet
And you will end by weeping."
"The planting of non-glutinous proso-millet
and beans together,
Will equal the joy of the nephew at
meeting his uncle;
But the planting of non-glutinous proso-
millet and foxtail millet together
Will cause them both to weep."

Some examples of good rotations may be cited. In the southern portion of the wheat area of North China, where two crops a year are grown, rotations such as the following are used:

Three years of winter wheat followed each year during the summer by soybeans, and in the fourth year, kaoliang as the cultivated crop and the only crop of the year.

Winter wheat followed by millet during the summer and in the second year, winter wheat and field peas planted together followed by a summer crop of sesamum.

On poorer land the legumes form an important feature of the rotation. First year: winter wheat and field peas planted together followed by a summer crop of soybeans. Second year: winter wheat followed by a summer crop of mung beans. Third year: winter barley followed by soybeans.

In the rice area, typical examples are four years of winter wheat followed each summer by rice, and the fifth year *Astragalus sinensis* as a winter green manure crop followed by rice. Another four-year rotation consists of two years of winter wheat followed by rice, and two years of *Astragalus sinensis* followed by rice. On low land, a typical example is broad beans in winter followed by rice and, in the second year, winter wheat followed by rice.

Many of the crop rotations used in China are unknown elsewhere. Some of them could very well be tried in other countries.

Extensive use of water, control of soil erosion, fertility maintenance, crop rotations, and control of weeds account for China's continuing high crop yields. But these yields can be further increased with plant breeding, control of insects and diseases, a still greater use and control of water, more soil conservation, improved pasture management and more extensive use of chemical fertilizers.

So, although China is remembered by many as the horrible example of soil erosion, it has much that is not so well publicized which other countries can learn with profit. Professional people have been finding out for years that not all of China's lessons for the world have yet been learned.

Education in Conservation

(*Continued from page* 139)

this learning can take place as the experienced and less experienced conservation farmers work together as well as in planned educational activities and in supplying technical assistance to groups and to individuals.

The numerous education methods, materials, procedures and techniques should be selected and adapted or developed to meet specific needs and objectives, locally and seasonally. Many methods can be effectively applied in organized conservation institutes, short courses, and adult classes. In the farm-in-a-day programs about every known method in imparting information and education has been used.

Visual aids of many kinds may be used when it is not possible to learn from observation and experience right on the land. Remember we learn 90 percent of what we learn through what we see.

In developing farm plans and making changes in land use and farm and ranch practices much judgment is involved. The educational devices should be adapted to develop this judgment. In developing judgment emphasis needs to be placed on the why—the land conditions and needs, the land use capability classes, the results in physical changes, production, and income that have been shown in previous conservation work. Discussions—exchange of ideas, and learning from the experiences of others in whom there is confidence helps in forming judgment and determining upon action.

"*Every person*", says Edward Gibbon, English Historian, "*has two educations, one which he receives from others, and one, more important, which he gives himself.*" We must provide for the people the information that will enable them to educate themselves on every phase of soil and water conservation adapted to their interests.

The Value of Crop Rotations for Soil and Water Conservation

R. E. UHLAND

Crop rotations have long been an important factor in American Agriculture. The data presented in this article will show, for example, that corn yields begin to decline with the loss of the first inch of topsoil and continue until all the topsoil is removed. Yields of other crops are also lowered where topsoil is removed. It further points out—and this is based on experimental data—many of the fundamental reasons why one cropping system proved better than others in conserving soil and water. Another highlight of the paper shows the loss of soil and water from land in different rotations and systems of cropping; also an evaluation of rotations on the basis of their efficency in controlling erosion.

GOOD CROP ROTATIONS provide for systematic cropping of the land in a way that will stabilize the soil and maintain or improve fertility, increase yields, and improve the nutrient value of crops. The rate of soil loss must be reduced below the maximum rate consistent with permanent use of the land, and at the same time the land must produce economic returns.

If the land is very steep, only sod crops or trees can protect it against serious erosion. If it is gently rolling, rotations that provide a sod cover one, two, or more years out of three to five years will keep the soil from deteriorating. The data which follow show that any cropping system—to be fully effective—must be supplemented with other conservation practices, such as good seed, timely operations, contouring, terracing, application of plant food, amendments, return of crop residues and manures and strip cropping—according to the needs of the particular field or farm.

From 1935 to 1939 intertilled crops were grown on 46 percent of all the land used for crops in five North Central States (1)—which include Ohio, Indiana, Illinois, Iowa, and Missouri. In 1943 and 1944 the corresponding percentages of all cropland on which intertilled crops were grown in the two periods were 45.7 and 52.5. In Illinois they were 50 and 56.9 percent and in Ohio, 38.2 and 45.5. With such proportions of all the cropland under clean tillage in 1943 and 1944, the best possible sequence of crops would not have made possible the use of soil-conserving rotations or prevented exploitation of our soil resources.

At Bethany, Mo. (2), a Shelby loam soil cropped annually to corn for ten years lost 27.2 percent of the rainfall as runoff and on an average lost annually 50.9 tons of soil per acre—equivalent to more than one-third of an inch. Adjacent land cropped to a 3-year rotation of corn, wheat, and hay lost 16.5 percent of the rainfall as runoff and only 7.51 tons of soil per acre annually. Continuous covers of alfalfa and bluegrass permitted only 6.7 and 8.1 percent runoff, respectively, with only a trace (0.15 tons per acre) of soil loss.

At Zanesville, Ohio (3), the average annual soil loss from the continuous corn plot was 99.3 tons per acre—compared with 13.4 tons per acre for the 4-year rotation. The soil loss from first-year meadow was 0.58 tons per acre and for second-year meadow it was 0.22 tons. From improved grass the loss was but 0.028 tons of soil, with 4.75 percent of the rainfall lost as runoff. The loss from the 4-year rotation was yet too high (13.4 tons per acre), showing that supplemental treatments, such as contouring, fertilization, and residue management, were needed.

Similar results were obtained on Marshall silt loam near Clarinda, Iowa (4). For the 10-year period 1932-1942, land cropped annually to corn lost 3.2 times as much of the precipitation and 5.32 times as much soil as land in the 3-year rotation of corn-oats-clover. Low runoff and only a trace of soil were recorded for plots in alfalfa and bluegrass. A marked cumulative influence of these crops in reducing erosion became evident when the land was plowed and planted to corn.

Sod Crops Condition and Stabilize the Soil

Much of the benefit derived from growing sod crops is due to the influence that these crops have upon aggregation of soil particles. The improved structure accompanying this aggregation permits rapid movement of water and air into and within the soil and prevents excessive runoff.

The Marshall silt loam plots on which alfalfa and bluegrass had been grown were found to have 50 and 58 percent greater aggregation, respectively, than plots on which corn had been grown annually. The improvement in aggregation on the plots formerly in alfalfa and bluegrass was still evident when these plots had been

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cropped to corn for three years. The losses of water and soil from the plots for the three years they were in corn—1943 to 1945—were markedly less than those from plots where corn was grown annually for three years after one year of clover. This shows that land should be kept in a hay crop two or more years at a time in order to secure better aggregation, add more stable organic matter, and thereby better condition and stabilize the soil.

Counts were made at Bethany, Mo. (4), of the number of drops of water falling 30 centimeters that were required to disperse an average aggregate about the size of a small pea and wash it through a 20-mesh screen. These tests were made on 180 aggregates taken from the surface inch of soil on each of the control plots that were under varying cropping and cultural practices.

Only 6.2 drops of water falling 30 centimeters were required to entirely disperse the average aggregate from soil that had been cropped annually to corn. In contrast, 37.7 drops to disperse aggregates taken from first-year meadow; 41.2 drops for aggregates after second-year meadow; and 40.2 drops for aggregates taken from land that had been in alfalfa for 13 years.

All over the country we can observe the superior physical condition of soils under sod. Where sod has been turned under for corn, more rapid infiltration and percolation and less runoff and erosion occur. Microbial activity and aeration are greater than where corn has been grown annually.

Rotations Insure Higher Per Acre Yields

Table 1 (5) gives the annual yields of crops and of digestible nutrients produced under different cropping systems; also nitrogen content of the plow depth of soil at the end of the experimental period 1921-1935 as reported by the Ohio Agricultural Experiment Station at Wooster.

Where corn had been grown annually for 15 years, only 1,425 pounds of nitrogen remained, compared with 2,075 pounds for a 2-year rotation; 2,263 for a 3-year rotation; 2,450 and 2,487 pounds for 4- and 5-year rotations, respectively.

Table 1. Average Annual Yields of Crops and of Digestible Nutrients Produced under Different Cropping Systems, also Nitrogen Content of Cropped Soil at End of Period 1921-1935

Ohio Agricultural Experiment Station, Wooster

Item		Corn Annually	2-yr. Rotation	3-yr. Rotation	4-yr. Rotation	5-yr. Rotation
Corn	*Bushels*	27.0	64.0	77.2	70.6	82.1
Oats	do	.....	.....	.....	.....	62.9
Wheat	do	.....	32.4	38.3	38.4	.....
Alfalfa						
First Yr.	*Tons*	.....	.....	2.74	3.17	2.63
Second Yr.	do	.....	.....	.....	4.10	3.59
Third Yr.	do	.....	.....	.....	.....	3,92
Total Digestible Proteins[1]	*Pounds*	108	237	382	520	533
Total Digestible Nutrients	do	1,215	2,250	2,710	3,092	3,055
Total Ntirogen[2]	do	1,425	2,075	2,263	2,450	2,487

[1]Calculated on basis of harvested grain and hay.
[2]Nitrogen in plow depth.

Figure 1. This scene shows the deterioration of soil when corn follows corn planted up and down the slope.

The per-acre yield of corn increased as the length of rotation increased—especially the length of time the land was occupied by hay. The total digestible protein as well as the total digestible nutrients produced with the 4- and 5-year rotations was markedly higher than for continuous corn or for the 2- and 3-year rotations. Still we have the common complaint that we can't afford to cut our corn acreage.

Corn Yields Proportional to Depth of Topsoil

In a cooperative study conducted in 1939 and 1940, in the states of Indiana, Ohio, Iowa, and Missouri a direct relationship was found between the organic matter content of the soil and pre-acre yield of corn. In like manner, we found a direct relationship between the depth of topsoil and corn yield. (Table 10).

The runoff and soil losses from plots in each group of a 4-year rotation and in continuous cotton at Statesville, N. C. (6), are shown in Table 2. A marked difference was noted in both runoff and soil loss, especially in the soil loss from different crops in the rotation. More striking is the excessive runoff and soil loss that occurs under continuous cotton. From an efficiency standpoint this rotation was but 53.7 percent effective.

Table 2. Runoff and soil losses from plots in each crop of 4-year rotation and in continuous cotton. Conservation Experiment Station, Statesville, N. C.[1]

Crop	No. of Crops	Rainfall	Runoff	Soil Loss Tons/A
Crops in Rotation				
Corn	8	47.80"	10.7%	28.69
Wheat and Lespedeza	7	48.20"	13.5%	5.61
Lespedeza	9	47.48"	5.3%	1.52
Cotton	8	47.80"	10.4%	21.82
Ave. 4-Yr. Rotation		47.80"	10.0%	14.44
Continuous Cotton	8	47.80"	12.4%	31.22

[1]Data for period 1931-1938.

Supplemental Conservation Practices Needed for Maximum Production

Soil and water losses from plots in peas grown in a 3-year rotation at Marcellus, N. Y. (7) were markedly affected by supplemental treatment. (Table 3). For example, where a low rate application of manure was plowed under preceding the planting of peas, the soil loss amounted to 18.79 tons per acre, whereas a heavy rate turned under gave a soil loss of 12.66 tons per acre. By using the low rate as a top dressing (that is, leaving it on the surface) the soil loss was 3.31 tons and the water loss was about one-half that which took place when the manure was plowed under. Where the heavy manure application was made as a top dressing, only 0.66 tons of soil was lost. This represents but 3.5 percent as much soil as was lost from the same crop where a low rate of manuring was applied and turned under. It was 5.2 percent of the loss that occurred where a high rate application of manure was turned under. These results point out the need for combining practices so that one supports another.

Marked effect of mulch or crop residues was noted on rate of runoff from corn and soybeans at Urbana, Ill., April-May 1943 (8) (Table 4). In this experiment water was applied as simulated rainfall at the rate of 1.75 inches per hour and the runoff was measured at the end of 30, 60 and 240 minutes. For both corn and soybeans, the addition of either wheat straw or soybean residue to the surface soil that had previously grown soybeans resulted in markedly reducing the water loss for each time interval.

Table 3. Soil and water losses from plots in peas in 3-yr. rotation with different treatments—Marcellus, N. Y. 1947[1]

Treatments	Water Loss Inches	Soil Loss Tons per acre
Low rate manure, plowed under	1.73	18.79
High rate manure, plowed under	1.62	12.66
Low rate manure, top dressed	0.86	3.31
High rate manure, top dressed	0.77	0.66

[1]Soil and water losses for period June 30-December 31, 1947.

Table 4. Effect of mulch or crop residue on rate of runoff from corn and soybeans, Urbana, Ill. April-May 1943[1]

Crops and Mulch	30 Minutes[2]	60 Minutes[2]	240 Minutes[2]
Soybeans—unmulched	1.43"	1.55"	1.60"
Soybeans—Wheat straw	0.21"	0.32"	0.47"
Soybeans—Residue	0.27"	0.43"	0.94"
Corn—unmulched	1.05"	1.35"	1.51"
Corn—Wheat straw	0.07"	0.09"	0.49"
Corn—Stover residue	0.11"	0.15"	0.65"

[1]Assimilated rainfall applied at rate of 1.75" per hour.
[2]Rate of runoff in inches per hour at indicated time intervals.

The runoff from soybean land which had received the mulch of wheat straw was only about 11 percent for the 30-minute period, 18 percent for the 60-minute period, and a little less than 27 percent for the 240-minute period. More than 90 percent of the rainfall was lost as runoff where the land was unmulched and no crop residue remained. In like manner, the addition of wheat straw as a mulch to cornland reduced the runoff from 1.35 inches at the end of 60 minutes to 0.09 inch. At the end of 240 minutes the runoff from unmulched corn was 1.51 inches, compared with 0.49 inch where a straw mulch was used.

Organic Matter Regulated by Cropping System and Cultural Operations

Table 5 shows the data on soil renewal plots at the Bethany, Mo. (9), Soil and Water Conservation Experiment Station. The organic-matter level in the exposed subsoil is markedly less than that contained in the moderately eroded surface soil. Even after 11 years of cropping and the return of considerable crop residues and manure, the organic-matter level had been only slightly increased.

If these rates of change in organic matter on these desurfaced plots continue, it will require 66 years of crop-

Table 5. Data on soil and water conservation experiment station, Bethany, Mo.

Plot No.	Cropping System	Treatment	Corn Yield 1942 Bu. per A.	Organic Matter 1943 Percent	Soil Loss 1932-42 Inches	Water Loss 1932-42 Inches
1	Corn-Oats-Hay-Hay	None, Normal Soil eroded	43.0	2.84	0.83	42.9
2	Corn-Oats-Hay-Hay	None, Desurfaced Soil (subsoil)	20.5	1.93	1.22	48.4
3	Corn-Oats-Hay-Hay	Lime + Phosphate	34.6	1.96	0.53	29.7
4	Corn-Oats-Clover + Timothy	Lime + Phosphate	32.6	1.89	0.76	39.6
5	Corn-Oats-Sweet clover	Lime + Phosphate	44.0	2.00	0.72	33.0
6	Corn-Oats-Sweet clover	Lime + Phosphate + Manure	64.6	2.26	0.62	34.1
7*	Grass-Legume mixture	Lime + Phospate	44.2	2.16	0.007	12.1

*Plot 7—all residue left on land.

ping to a 4-year rotation of corn-oats and 2 years of hay to build the organic matter up to the level contained in the topsoil as it was tested in 1930. By liming and fertilizing and seeding to a grass-legume mixture (plot 7) and allowing all the organic matter to fall back on the desurfaced soil, the organic matter equivalent to that contained in the original topsoil could be attained in a little less than 30 years.

Exposed subsoils, however, are usually more difficult to cultivate, allow more runoff, have less plant food, and make less effective the rainfall with which to make a crop. Unless erosion and runoff are controlled, much of the plant food applied as fertilizer may be lost. I should like to point out that the cultural operations on these soil renewal plots were carefully performed and the runoff and soil losses were held to a minimum. Under field conditions, plowing of severely eroded lands or exposed subsoils average much shallowed, and the runoff and soil losses are much greater.

The rates of change in organic matter (9) recorded for the desurfaced plot are greater than would occur under normal field conditions. Cultivated soils accumulate organic matter at a much slower rate as the organic matter level rises. In other words, we would expect it to take a great deal more time and be much more difficult to increase the organic-matter content of a soil at a given location from 2.5 percent to 3.5 percent than to increase it from 1.5 percent to 2.5 percent. It should be pointed out that plot 1, the normal surface soil, contained 3.02 percent organic matter in 1932 but without treatment declined to 2.84 percent—a loss of 0.18 percent or 1.8 tons per acre in 11 years under a 4-year rotation. The accumulation of organic matter in these soil-renewal plots will become increasingly slower, and the time required to bring the organic matter above three percent (that found in the topsoil removed in 1932) will be much greater than that indicated above. There is a big question as to whether it can ever be raised to this point while cropped to cultivated crops. If left in grass and legumes, as in plot 7, it is possible that in time the organic matter would be restored.

A glance at the corn yields shows that the yield for a 4-year rotation on exposed subsoil is less than half the yield of corn on the untreated, moderately eroded topsoil. With the addition of soil amendments, fertilizer, manure, and turning under sweet clover on plot 6, a fairly good yield of corn was secured in 1942. Since the organic matter level, however, on this plot had only increased to 2.26 percent, we can expect this type of yield to occur only occasionally.

Reference was made to the relation of organic matter or nitrogen to crop yields at Bethany, Mo. and at Wooster, Ohio (10). Table 6 shows that with 13 years of corn a total of 4.94 inches of soil were lost and the organic matter had declined from 3.25 percent to 2.23 percent.

Under clean fallow (where the land was turned with a plow each spring and kept cultivated as for corn but no crop planted), the soil loss in 13 years totaled 7.88 inches. The organic matter level of the plow depth (0 to 7 inches) declined from 3.25 to 1.93 percent. Where a 3-year rotation of corn-wheat-hay was practiced without lime and fertilizer or the utilization of crop residues, the soil loss was 0.88 inch and the organic matter remained practically the same as at the beginning of the experiment.

Under 13 years of alfalfa and grass the soil loss was practically nothing—namely, .01 inch. The organic matter under alfalfa increased to 3.93 percent and under grass to 3.61 percent. The freshly exposed subsoil in 1930 showed 1.71 percent organic matter in the 0- to 7-inch layer. After 13 years of clean fallow, the organic matter had declined to 1.41 percent. During the 13-year period 5.54 inches of soil were lost.

Table 6. Organic matter in plow depth, surface and desurfaced soil under different cropping systems. Bethany, Mo.

Plot No.	Description and Treatment	Organic Matter Percent	Soil Loss Acre Inches
	Surface Soil		
2	13 Yrs. Corn Annually	2.23	4.94
3	13 Yrs. 3-Yr. Rotation. No Tr.	3.23	0.88
7	13 Yrs. Alfalfa, L + P	3.93	0.01
8	13 Yrs. Grass—No Tr.	3.61	0.01
9	13 Yrs. Clean Fallow, No Tr.	1.93	7.88
	Desurfaced Soil		
10	Freshly Exposed—1930	1.71	—
10	13 Yrs. Clean Fallow	1.41	5.54
2	12 Yrs. 4-Yr. Rotation—No Tr.	1.93	1.38
7	Grass Legume Mix.—L + Fert.	2.16	0.01
6	12 Yrs. 3-Yr. Rotation—L + Fert. + M	2.26	0.70
8	4 Yrs. Corn — 8 Yrs. Oats + Lesp. + L + Fert. + M.	2.15	0.20

Figure 2. Protected against erosion and loss of moisture, this alfalfa-brome pasture provides grazing at the rate of two steers for each acre.

Under a 4-year rotation that was practiced on an exposed subsoil which was treated with lime and fertilizer and the residues turned under, there was a loss of 1.41 inches of soil, but the organic matter increased to 1.93 percent, a gain of 0.22 percent.

The organic matter distribution by soil depths for the Marshall silt loam near Shenandoah, Iowa and the Shelby loam near Bethany, Mo. is shown in Table 7. In both of these soils the organic matter is markedly higher in the upper 8 inches. This is especially true for the Shelby loam. It will be noted that the Marshall silt loam contained 1.8 percent organic matter in the 24- to 28-inch layer, which was about the same quantity as that found in the Shelby at a depth of 12 to 16 inches. Permeability measurements on these soils show that the Marshall soil transmits water much more rapidly than does the Shelby.

Table 7. Organic matter for different soil depths, comparing Marshall silt loam with Shelby loam.

Marshall Silt Loam		Shelby Loam	
Soil Depth Inches	Percent	Soil Depth Inches	Percent
0-4	3.4	0-4	3.6
4-8	3.4	4-8	3.6
8-12	3.1	8-12	2.3
12-16	2.6	12-16	1.7
16-20	2.5	16-20	1.5
20-24	2.0	20-24	1.2
24-28	1.8	24-28	0.8
28-32	0.6	28-32	0.4

Land Needs Extra Protection When in Clean Tilled Crops

In order to protect land against the many erosion hazards we must provide canopy protection for the land, especially when it is occupied by cultivated crops. Table 8 shows the effect of applied mulch on the yield of corn and soybeans at Urbana, Ill. (8) These are the same plots as those in Table 4, which showed the protection given against erosion. Keeping crop residues on or near the surface, or adding a straw mulch, markedly reduces erosion. It is therefore important to know what effect this same treatment may have upon crop yields.

The yield of corn for 1943 was practically the same for mulch and no mulch. For the other two years there was a marked decline in the corn yields where the straw mulch was used, so that for the 3-year period there was

Table 8. Effect of applied mulch on yields of corn and soybeans.[1]

	Corn Yield—Grain per acre		Soybean—Hay per acre		Soybeans—Seed per acre	
Year	Mulch (Bushels)	No Mulch (Bushels)	Mulch (Bushels)	No Mulch (Bushels)	Mulch (Tons)	No Mulch (Tons)
1941	81.1	90.5	——	——	3.28	2.64
1942	55.1	92.5	36.2	37.4	3.05	3.73
1943	93.2	95.1	26.8	21.0	——	——
Average	76.5	92.7	31.5	29.2	3.27	3.19
Difference	—16.2		+ 2.3		—0.02	

[1]Experiment carried out at Urbana, Illinois.

Table 9. Corn yields in bushels per acre from different depths of topsoil for different locations in Region 3, for 1938-1940.

Depth of Topsoil,	Bethany, Mo. Av. 7 Fields	Fowler, Ind. Av. 16 Fields	Fowler, Ind. Av. 18 Fields	Shenandoah, Ia. Av. 10 Fields	Greenfield, Ia. Av. 12 Fields
inches	1940	1939	1940	1939	1938
13+	67.5	93.4	69.5	—	—
11-12	57.8	88.6	62.4	119.9	63.9
9-10	55.4	82.3	56.8	109.0	58.1
7-8	50.4	73.4	53.1	92.7	45.8
5-6	43.7	66.7	47.0	79.6	42.8
3-4	35.4	58.3	39.2	65.4	38.4
1-2	24.9	49.2	30.0	52.3	31.8
0-1	15.2	—	19.8	—	—
Average	43.4	74.5	54.6	81.7	42.6

Data were secured by Operations and Research technicians of the Soil Conservation Service in cooperation with State Agricultural Experiment Stations.

a difference of 16.2 bushels in favor of the "no-mulch" areas.

For soybeans the mulched plot overaged 2.3 bushels higher than the "no mulch." There was little difference in the yield of hay. Table 9 shows the corn yields from different depths of topsoil for a number of locations in Region 3 for 1938, 1939, and 1940. (6) At Bethany that the corn yield for those areas in the fields that had 13 or more inches of topsoil was 67.5 bushels per acre. Where there was less than seven inches and more than five, the yield averaged 43.7 bushels, while where practically all the topsoil was gone the yield was only 15.2 bushels. The average for the field was 43.4 bushels per acre.

At Fowler, Indiana, in 1939, the average corn yield for areas having 13 or more inches of topsoil was 93.4 bushels per acre, while where there was from one to two inches of topsoil the yield averaged 49.2 bushels. At the same location in 1940 corn yields were not as high but the yields for those areas having more than 13 inches of topsoil was 69.5 bushels per acre, while the yield for those areas where practically all the topsoil was gone was 19.8 bushels per acre.

How Effective Are Cropping Systems?

In Table 10, the efficiency of the cropping systems at Bethany, Mo., with and without supporting practices for controlling erosion, are shown. The efficiencies are based upon a standard of efficiency shown in the two columns at the extreme right. By using the standard of effiicency shown in this table, the relative efficiency of cropping systems at different locations throughout the country may be compared.

Attention is called in Table 6 to the 4-year rotation of corn-oats-wheat-hay where farming was carried on parallel to the field boundaries without regard to slope. The efficiency of this system of farming, although lime and fertilizer were used but residues removed, was only 30.9 percent. On the other hand, where this same rotation or cropping system and treatment (except that residues were returned) was followed in combination with contouring and the use of well established grassed waterways, the efficiency was increased to 76.5 percent.

Where terraces were added to the latter system, the efficiency was increased to 88.2 percent. A 3-year rotation of corn-oats-hay with lime and fertilizer at Bethany,

Table 10. Efficiency of cropping systems, Bethany, Mo., with and without supporting practices for controlling erosion—based upon standard of efficiency shown at right.

	Efficiency of Farming Systems. Bethany. Mo.			Standard Efficiency	
Cropping System[1] on 8% slope	Treatment	Time to erode 7 ins.	Efficiency Percent	Time to erode 7 ins.	Efficiency Percent
		Yrs.		Yrs.	
Corn—annually	None	18.8	18.8	—10	0
Corn—annually	16 Tons Manure	27.8	23.9	10	10
Corn-Wheat-Hay	None	108.2	43.5	20	20
Corn-Wheat-Hay	Lime + Phosphate	137.0	47.1	40	30
Corn-Oats-Hay	Lime + Phosphate	167.8	50.5	80	40
Corn-Oats-Hay	Lime + Phosphate + Manure	413.5	62.9	160	50
Corn-Soybeans-Oats-Hay[2]	Lime + Phosphate	66.3	36.6	320	60
Corn-Soybeans-Wheat-Hay	Lime + Phosphate	128.3	46.0	640	70
Corn-Oats-Wheat-Hay	Lime + Fertilizer; farmed parallel to field border	43.4	30.9	1,280	80
Corn-Oats-Wheat-Hay	Lime + Fertilizer; waterways; contoured	1,033.3	76.5	2,560	90
Corn-Oats-Wheat-Hay	Lime + Fertilizer; terraced; contoured	2.333.3	88.2	5,120+	99+
Bluegrass	Lime + Phosphate	6,666.6	99+		

[1]Topsoil about half gone. Crop residues removed from first five plots.

[2]Soybeans before oats in cultivated rows for seed, before wheat was drilled. (Soybeans harvested for hay.)

By using this standard of efficiency, the efficiency of cropping systems at different locations throughout the country may be compared. Two examples of how the efficiency is calculated follow:

1. Time required to erode 7 inches — 27.8 years.
   Efficiency = $20\% + \frac{27.8 - 20}{20}$ of $10 = 23.9\%$

2. Time required to erode 7 inches — 137.0 years.
   Efficiency = $40\% + \frac{137.0 - 80}{80}$ of $10 = 47.1\%$.

Figure 3. A sweetclover cover crop seeded in corn at the last cultivation furnishes a good vegetative cover and adds needed organic matter to the soil.

Mo. proved more efficient in controlling erosion than did a 3-year rotation of corn-wheat-hay without treatment. The return of crop residues and manure to the corn-oats-hay plot that was treated raised the efficiency from 50.5 percent to 62.9 percent.

For a rotation of corn-soybeans-wheat-hay where the soybeans were drilled solid and where wheat was seeded as soon as the soybean hay was removed, an efficiency of 46.0 percent is shown, as compared with an efficiency of only 36.6 percent where a rotation of corn-soybeans-oats-hay is used. In the latter rotation soybeans were planted in rows and cultivated and removed for hay. This left the soil bare during the winter and early spring and allowed excessive soil and water losses.

Summary

In summary, crop rotations for most effective soil and water conservation must:

1. Supply cover or protection of the proper kind and amount at the time when it is most needed.
2. Condition the soil with vigorous-growing grasses and legumes to resist erosion when clean-tilled crops are grown.
3. Include cover crops to supply organic matter and as near year-round protection as possible.
4. Include use of soil amendments and fertilizers for effective erosion control, maintenance of organic matter, and economic production.
5. Provide for best use of crop residues, manure, and cover crops, especially while land is in row crops.
6. Include other needed supporting soil and water conservation practices, such as contouring, strip cropping, and terracing.

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(Continued on page 160)

Figure 4. Soybeans planted and cultivated on the contour conserve soil and water. Terraces are often needed on long slopes as supporting practices.

Application of Strip Cropping and Contour Cultivation in the Northeast

JOHN P. JOHNS

WHILE STRIP CROPPING is often associated with the present soil conservation movement, it has in fact been used by some farmers in the Northeast for many years. In certain communities of Pennsylvania, West Virginia and southeastern Ohio some farmers with long, more or less uniform slopes, on their own initiative, plowed and cultivated across the slope, with the crops arranged in strips.

Walter (1) in a study of strip cropping on 19 farms in southwestern Pennsylvania reported in 1937 that two of the farmers had practiced strip cropping for more than 20 years. Most of these farmers started strip cropping to prevent erosion. Many of them had come to recognize some of the principles we hold firmly today. They adjusted the width of strips in accordance with the steepness of slope, with strip widths running around 168 feet on slopes of 1-15 percent and 86 feet on slopes over 21 percent. Although laid out by the eye, the strips were from two to five percent off contour. Some had made adjustments to provide narrower strips more nearly on the contour.

When the Soil Conservation Service started work in the Northeast it was confronted with the problem of introducing measures that would fit into the farming practices, reduce runoff and control erosion. Strip cropping was one of the important means the technicians investigated. They found experimental evidence indicated that laying out crops in strips and cultivating on the contour reduced soil losses. Farmers who had tried it confirmed these results. Later conclusions from plot experiments (2) have shown that contour, in contrast with up-and-down-hill planting and cultivation, reduced soil losses as much as 52 percent, and that strip cropping reduced the annual soil loss by 55 percent in comparison with that from contour cultivation alone. Observation of the plots showed that the tendency for water to concentrate and form gullies was markedly greater on the plots which were not strip cropped.

With such facts at hand as were available, the technicians undertook to work out the application of strip cropping with farmers. Certain guiding principles had to be kept in mind: (1) strip cropping must be made to fit into the farm management; (2) it must be related to other soil conservation practices needed on the farm; (3) it should be used as a means of increasing the effectiveness of the rotation in controlling erosion; (4) strips should be laid out as nearly on the contour as possible; (5) consideration should be given the degree of erosion, the percentage of slope, and the length of the rotation; (6) the ultimate objective of any plan of strip cropping should be to keep the soil intact, improve soil fertility and produce the greatest possible economic return for the farmer.

As used in the Northeast, strip cropping may be defined as the growing of crops in a systematic arrangement of strips or bands which serve as vegetative barriers to erosion. It includes the utilization of crop rotation, contour cultivation, proper tillage, cover crops, and other related practices. The arrangement of crops in strips must be such that erosion- and semi-erosion-resistant crops are alternated with clean-cultivated crops that are conducive to erosion. Contour cultivation is not used to any great extent except with strip cropping and in orchards and truck areas. Strip cropping is regarded as more effective than contour cultivation alone and there have been no significant insect problems to make it desirable to use contour cultivation in lieu of strip cropping in certain localities.

Layout Methods Vary

To meet the problems found on the farms it has been necessary to vary the methods of laying out strips. In some cases the land was too irregular or poorly drained for the use of contour strips. On some farms rock outcropping made it desirable to adjust the methods employed. In trying to solve the application of strip cropping to the varying farm conditions, four types of strip cropping have been found to cover most of the problems. They are: (1) contour strip-cropping; (2) parallel-sided strips; (3) field strips; and (4) drainage or graded strips.

Contour strip cropping is recommended as most effective, and applicable on a large proportion of farms. The strip boundaries are laid out on the contour and the planting follows the contour lines with short rows in the middle. In practical layout on the farm, the level points are located every 50 to 100 feet and a plow is used to

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make the contour lines. The experience of farmers indicates that this method of strip cropping is most effective in controlling erosion and conserving moisture. In many instances, where the farmer has objected to contour strip cropping and has insisted on parallel-sided strips, he has later adjusted his strips so that they are on the contour. Soil conservation technicians do not now have so much difficulty in selling the idea of contour strip cropping. If a farmer is hesitant about adopting the contour principles the farm planner is usually successful in getting him to try one or two contour strips. After he learns that contour cultivation is not difficult he is willing to have the contour strips laid out on all his cropland. A few farmers have objected to having the short rows associated with contour strip cropping but this has not proved a serious problem except in the case of potatoes and cigar-wrapper tobacco.

Parallel-sided strips are used to some extent in the production of certain crops, such as potatoes and cigar tobacco. With parallel-sided strips there are no short rows. This facilitates the use of the sprayer and cultivator in the highridge culture system for potatoes and avoids bruising of the leaves for cigar tobacco, such as might result from turning in short rows. This type of strip may be laid out from a contour base line on one side or in the center of the strip. In order to maintain such strips approximately on the contour, it is necessary to use corrective areas. These areas are objectionable because it is not always possible to make the most desirable use of them.

Field strips are field divisions across the major slope. They are used to sub-divide large fields into two or more parts either for erosion control or to facilitate the balancing of crop acreages. Field strips are used under conditions of irregular topography where the application of contour or parallel-sided strips is impractical. In the glaciated sections, the kettle and kame topography, and in the limestone-ridged portions of the region, the ridge outcropping makes contouring very difficult. Under these conditions, field strips are used but where practical the land should be planned for crops that provide permanent cover.

Drainage strips are used on soils that are not naturally well-drained. They are laid out on a grade usually not exceeding one percent and facilitate the drainage of surplus water. They are planned in conjunction with terrace systems and diversion terraces and the grade should be in the direction of a stabilized outlet.

Strip cropping must be used in accordance with the land use capability. The width of strips is adjusted in accordance with the steepness of the slopes and the erodibility of the soil. In practice about 100 feet is considered a satisfactory width of strip on the less steep slopes but when the slope is greater than 15 to 18 percent, a narrower width is desirable. The rotation influences to a considerable degree the width of strips. If the rotation carries three or more years of hay, the width of strip can be greater.

The length of the rotation is a factor in any strip-cropping program. When the farmer does not require much grain, a long rotation can be adopted, with several years of well-managed hay, and the problem is relatively simple. Often it is necessary to shorten the rotation in order to provide the required grain. Sometimes this can be worked out by putting the short rotation on the more gentle slopes and using a long rotation on the very steep slopes. In order to protect the steeper slopes with long rotations, corn with a cover crop is sometimes recommended every year on the nearly level bottom land. Cover crops are an essential part of a good rotation and should be used to follow cultivated crops where they have a chance of success. Because of the lateness of harvest of such crops as potatoes, carrots, beets and cabbage in some parts of the Northeast, it frequently is not practicable to plant a cover crop.

Diversions and Grass Waterways Part of Plan

Diversion terraces are used widely as a supplement to strip cropping. On very long slopes, some method by which the water can be diverted has been found essential. If the watershed is long, strip cropping has been found effective near the top of the slope but on the lower part the water often tends to concentrate, causing considerable erosion. Establishing diversion ditches across the slopes at intervals to take care of the excess water prevents concentration and aids in the effectiveness of strip cropping.

Grass waterways are considered as part of a strip cropping plan. They are used to carry surplus water off the strips. It is generally a good plan, especially on imperfectly-drained soils, to grade the strips slightly toward such waterways. In the case of field strips and parallel-sided strips, the grass waterways are particularly essential. In these types of strip cropping, the planting and cultivation often leads the water toward the draws and if a grass waterway is not provided, gullies will result. In cultivating across waterways, farmers have to be careful not to cut up the sod. The waterways should be wide enough to carry the water and shaped so that it will not run over on the cultivated land, causing a gully. Ordinarily the width should be at least 12 feet.

The sequence of crops in strip cropping is important. The crops should be arranged so that no two cultivated strips are adjacent to each other. Oats, while a close-growing crop, is not a good crop to grow adjacent to corn because the land for both of these crops is plowed in

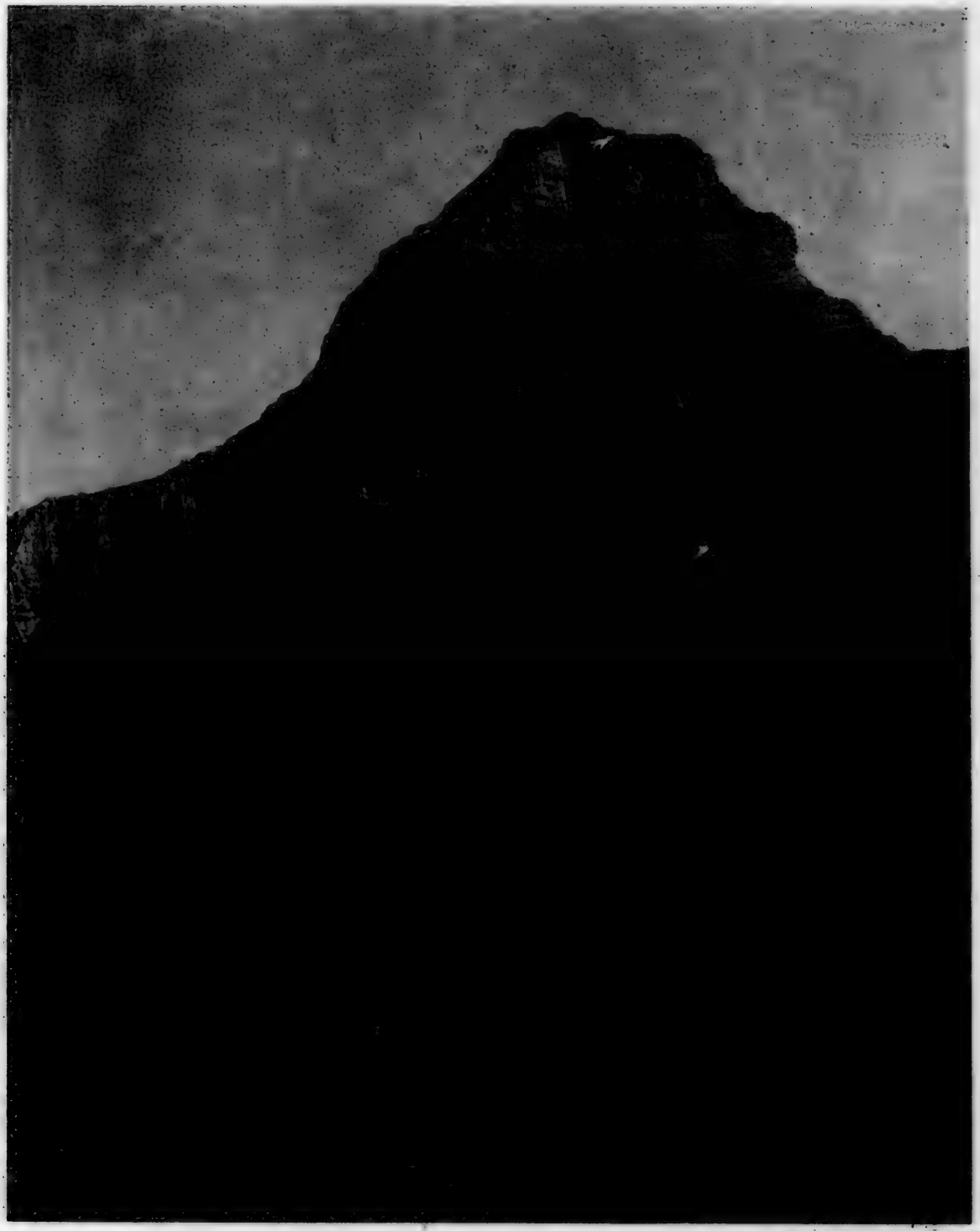

Photo by George A. Grant, NPS

Beauty and inspiration are high land values that are precious and irreplaceable. Kinnerly Peak and Upper Kintla Lake in Glacier National Park.

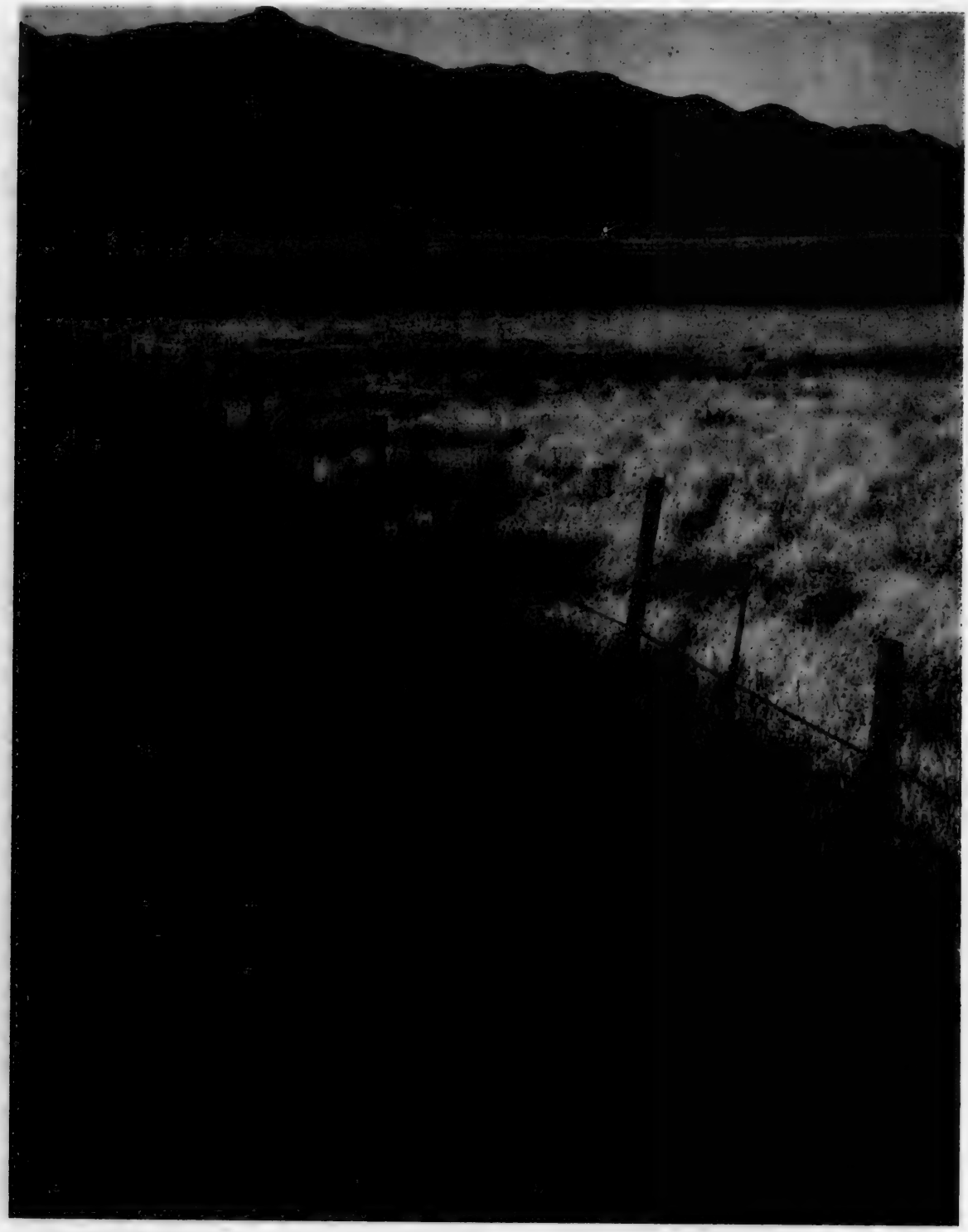

Photo by Brixner, SCS

Overgrazed range land is an abused heritage. In the intermountain country of southeastern Arizona, water spreading and controlled grazing convert desert into grassland.

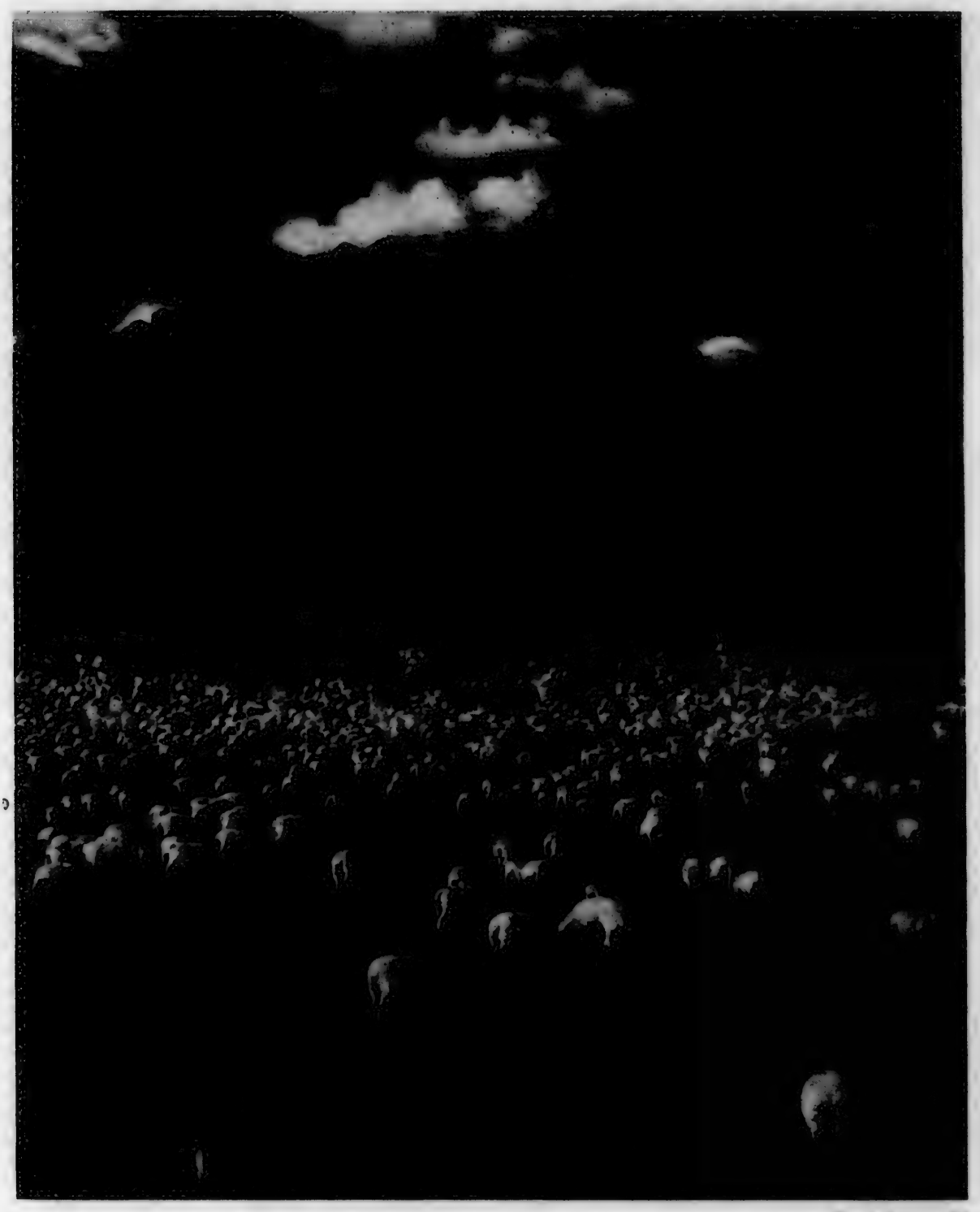

Photo by Branstead, SCS

On millions of acres of land throughout the western United States native grass is an invaluable resource. Here sheep in Idaho move through sagebrush range to summer in mountain meadows.

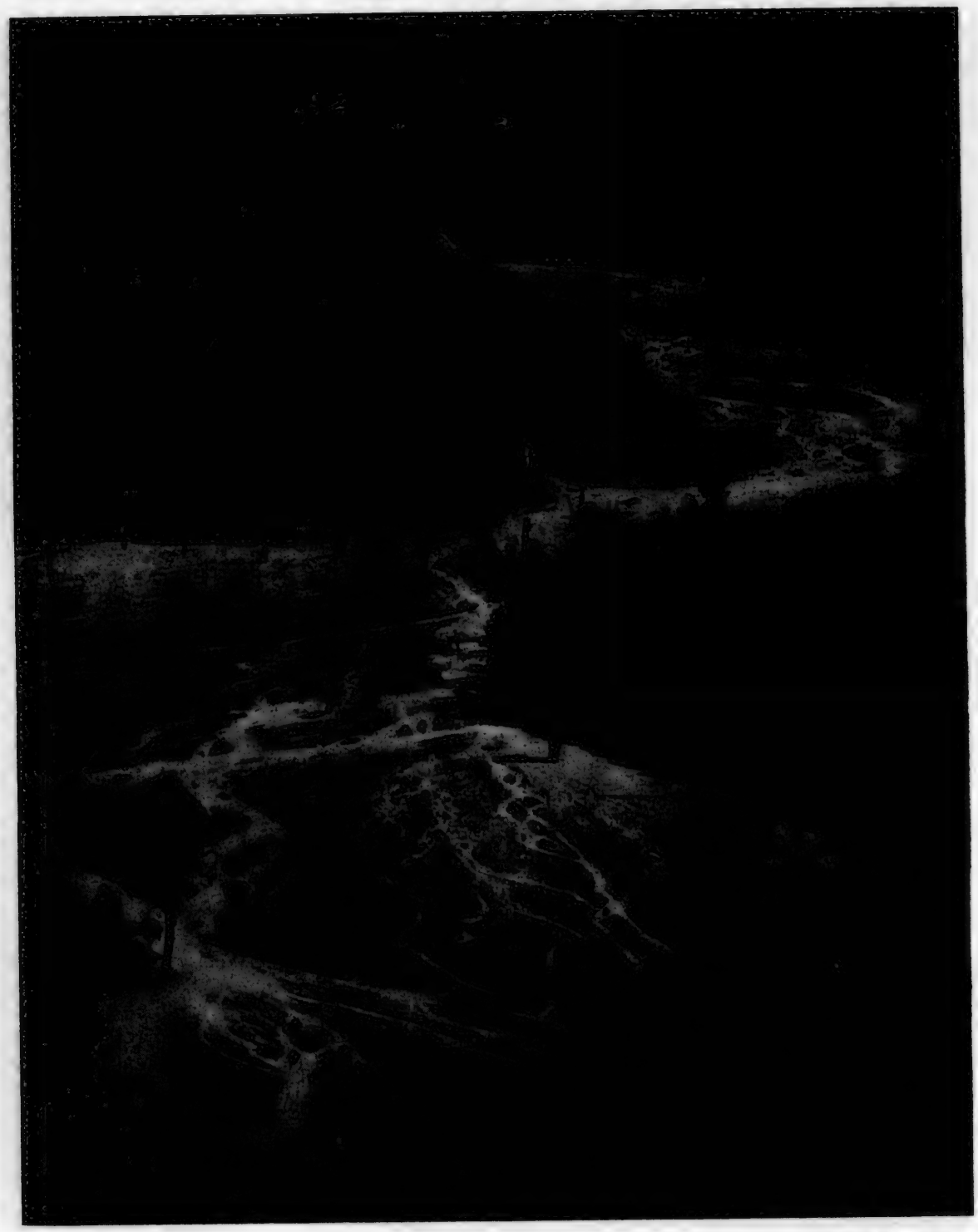

Photo by Ernest G. Holt

The Waipaoa River near Gisborne, New Zealand, cannot cope with the increasing load of silt coming from raw gullies cut into weak Tertiary and Caetaceous rocks. It is rising in the riverbed like a tide and even submerging the outlets of smaller streams. Tree trunks bear witness to the original forest cover.

Contour strips on these three adjoining Pennsylvania farms play an important part in controlling soil erosion and the runoff of water. Note the sod waterways in the old gullies and the peach orchard on the contour.

the spring. This can be avoided by putting corn and wheat in one field and oats and hay in another and alternating the two sets of crops back and forth to maintain the proper sequence in the rotation. Similarly, many other combinations of crops and rotations are used with the arrangement of crops worked out in accordance with the specific problem on the farm. In the adjustment of a rotation to make stripping most effective, grass and legumes always precede row crops wherever possible.

Much of the strip cropping is started in the spring and fall. In the spring, stripping can be started on a field in sod by plowing alternate strips for corn. Following corn in the fall, alternate strips of wheat can be planted. Sometimes wheat is seeded on the entire corn field and clover and grass seeded in alternate strips in the spring. From these beginnings, the complete rotation is worked into a strip-cropping system.

The problem of pasturing the meadows in a strip-cropping system has been discussed a great deal but it is not presented so often now. The use of the portable electric fence has made it possible for the farmer to graze meadows at his convenience even though some labor is involved in putting up the fence. Laying out the strips so that the small grain and hay are all in one field makes it possible to graze the meadow after the hay and grain are harvested. By planning the permanent pasture in relation to the pasture obtainable from the meadows in a strip-cropping system, temporary fencing can be reduced to a minimum and in many cases is unnecessary.

Not Applicable in Orchards

Strip cropping is not usually applicable in orchards. Contour planting and cultivation are widely used except for apples. Most apple orchards are maintained in sod. A well-managed sod will do a satisfactory job of controlling erosion without the aid of contour planting. In most cases the sod seems to offer no important competition with the apple trees for moisture. In a few areas of deficient rainfall where apples are grown, it is necessary to employ practices similar to those used for the stone fruits.

For stone fruits, contour planting and cultivation give better results than sod. The stone fruits require a lot of water during the period of fruit swell, the latter part of the summer. This is usually a time of deficient moisture and all that is available is required for the maturing fruit. To meet this problem, stone fruit orchards are planted on the contour or in graded rows in conjunction with terraces. During the early stages of growth, sod strips may be maintained in the middle of the rows allowing for adequate cultivation along the tree rows. When the trees begin to bear the sod strips are eliminated and a managed cover crop system is introduced. The cover crop is usually planted early enough to give a good winter cover. It is allowed to grow in the spring to produce a large yield of organic matter and then disked down. The trashy cultivation principle is followed. The cover crop is cut down to such an extent that it requires little or no water and the residue is left on or near the surface where it serves to control erosion and conserve moisture for the rapidly-growing fruit.

A scene in Stone Valley Watershed, Northumberland County, Pennsylvania, showing the importance of contour strip cropping in the agricultural pattern. The strips follow a corn, oats, wheat and hay rotation. A farm pond and orchard are also shown.

There are some problems in the planting and cultivation of fruit in graded or contour rows. These problems have to do primarily with spraying. For example, the new speed-type sprayer requires uniform width of rows for maximum efficiency. Such problems are being met and with the farmers' and machinery companies' growing appreciation of soil conservation they will be solved.

Trucking Areas

The Northeast has a number of intensive truck-growing areas. The soil of these areas while gently sloping is usually quite erodible. Cultivated crops are grown every year on the land with the aid of high applications of fertilizers and no system of strip cropping has been found that is practical. Contour cultivation in conjunction with terrace systems has been adopted as the most practical answer to the problem. Cover crops and green-manure crops are worked into the cultural system to maintain the organic matter.

It is frequently not possible to plant a winter cover crop because of late fall harvest. Effort has been made to plant cover crops in such crops as cabbage, beets, carrots and potatoes before harvest. There is some promise of success in such methods but the difficulties have not been mastered to the point where farmers have accepted them. More work is needed to obtain more satisfactory methods of establishing cover crops in late harvested truck crops and to secure a crop that can be counted on to give a cover after such crops are harvested.

In the case of crops where cover crops have not been applicable it has proven advisable to retire the land from truck to green manure crops at frequent intervals. In some cases the land is retired to a long rotation with several years of legume hay. A livestock enterprise is generally conducted with such a system, producing a lot of manure that will aid in building the organic matter.

Although farmers often have been reluctant to adopt strip-cropping systems, their merit is now well-established. As more farmers have worked with strip cropping, there has developed a growing appreciation of the many angles of application and of the variety of benefits. Properly applied, strip cropping and contour cultivation are widely recognized for their soil and moisture-conserving value. In addition, farmers are reporting savings in fuel, higher yields, lighter work for horses, greater ease in building and maintaining fertility, and better results from application of fertilizer and manure, as benefits resulting from the use of strip cropping.

The moisture-saving feature of strip cropping must not be overlooked. In areas subject to dry spells in summer, the additional water saved thru strip cropping is often enough to carry the crop without any setback from the dry weather. In a prolonged dry season the crops do not suffer as much as those that are not arranged in strips. Many of the increased yields associated with strip cropping and contour cultivation often may be attributed to a greater supply of available water in the soil.

Evidence from research and farmer experience is accumulating to show that strip cropping is a practicable and profitable method of farming. Its full value is by no means fully realized and it would be a mistake to give the impression that all of the problems of application have been solved. Instead, more intensive and extended research is needed to work out many of the problems that now stand in the way of a full utilization of strip cropping in its many relations to other practices and to farm operations. Such research should be correlated with an aggressive and alert farm conservation planning program. By such a scheme, research and farmer experience can go hand in hand, with both making suggestions and contributions.

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The Use of Surface Mined Land

L. E. SAWYER

Revegetation of areas from which coal has been removed is a problem of major concern in many sections of the country. This article traces the development of a successful revegetation program based on sound land use and research.

Studies referred to show that the survival of trees planted on levelled areas was less than twenty-five percent while on the unlevelled areas survival exceeded eighty percent. The growth was even more pronounced, ranging from less than one foot on the levelled portions to over six feet on the unlevelled. Other tests by the Central State Forest Experiment Station show that the rate of infiltration on levelled materials was only .6 inches per hour—thereby creating a serious soil erosion problem. The rate of infiltration on adjacent unlevelled areas was 3.9 inches per hour.

THE REVEGETATION OF AREAS from which coal has been removed by open cut coal mining is a new science. All of the basic information developed by the agricultural experiment stations and by the forest experiment stations has until the past few years dealt entirely with specific soil types as recognized by soils scientists. The materials in the banks turned up in the removal of coal do not correspond to any known types of soil. There are no soil horizons and there is no definite structure.

During the mining operations all of the material above the coal, whether it be glacial till, clay, sandstone, shale or limestone, is completely mixed with whatever soil may have been present on the area. This mixing operation produces materials that vary greatly from one dump of the excavating machinery to another. This wide range of materials and the constantly changing patterns make the job of revegetating these areas one that is extremely interesting and far more complicated than establishing vegetation on a specific soil type that is more or less uniform throughout.

A Quarter of a Century of Experience

The land use program of the open cut mine operators in Indiana—the oldest organized program of its kind—began more or less by accident a quarter of a century ago. One of the operators had taken his wife to the mine with him on a routine inspection trip about 1920. In reaching the mine they passed by a large area from which the coal had been removed. She asked what he proposed to do with the barren ridges of material. His reply was that he proposed to do nothing, whereupon she insisted that something be done. Consequently this mine operator sought the aid of the state forester's office and in the spring of 1926 he and several other far-sighted operators began reforesting areas of mined land.

That this approach at returning these lands to productive use was on an industry-wide basis rather than an individual company effort is borne out by minutes of a meeting of the Indiana Coal Producers Association of June 14, 1921. A resolution adopted at that meeting reads:

"Resolved that the members of the Indiana Coal Producers Association be requested to plant before December 1, 1921, a substantial number of forest trees, fruit trees, grapevines, on one or more sections of old waste banks."

Some of the minutes were later destroyed by fire so

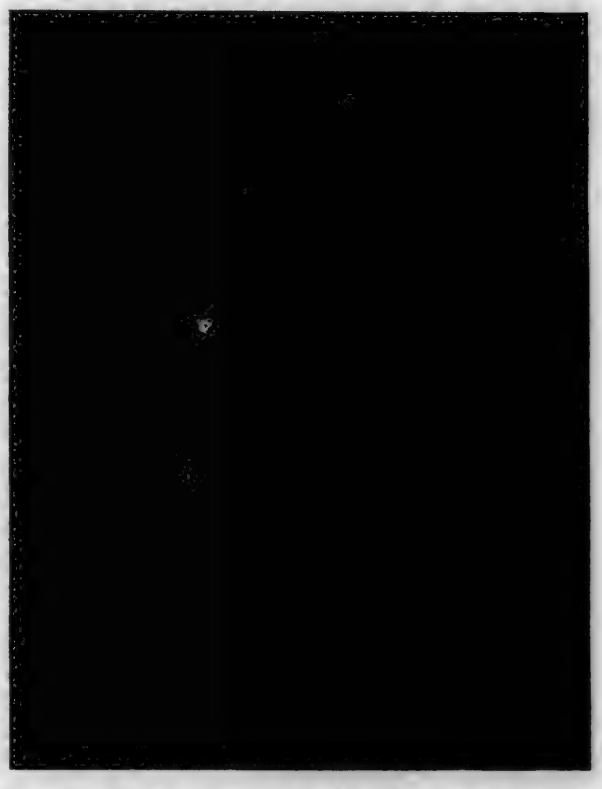

Figure 1. 20-year-old stand of Jack and Red pines planted in Sullivan County, Indiana. Volunteer Cottonwoods, Red, Jack and White Pine reproduction is abundant throughout the area.

Mr. L. E. Sawyer is Director of the Division of Forestry and Reclamation of Indiana Coal Producers Association. His headquarters are in Terre Haute, Indiana. Mr. Sawyer is recognized by the coal producing industry for his sound approach of revegetating mined land.

Figure 2. Plantation of White and Jack Pines established in 1926 in Owen County, Indiana. Six-foot man at base of pine in center foreground indicates height of tree.

there is no record of what was done as the result of that resolution, and it is not until 1926 that we have any record of industry-wide planting.

One company had made a planting of fruit trees in 1918. Many of these trees still stand and continue to bear but the forest plantings made in 1926 were the forerunner of the program as it exists today. There are records of plantings for practically every year since then, plantings which now aggregate more than 25 million trees. Exhaustive studies made by the Central States Forest Experiment Station show that forest vegetation had been successfully established on more than 25,000 acres prior to June 30, 1947. (These figures are published in Technical Paper 109 of that station.)

All of these early plantings were on a hit and miss basis. The state forester had no previous experience to guide him in the selection of species, nor could he obtain that information from any source. The resolution of June 14, 1921, called for fall planting, which we now know cannot be successfully done in this climate. The 1926 plantings and those established over the next five years on several hundred acres now stand as living monuments to the men who were willing to spend the money to see what could be done with mined lands, and to the foresters who directed their establishment. (Figure 1.) They, of course, selected some species which were doomed to failure but the early failures are now keeping us from repeating the same errors in our present and vastly more far-reaching planting program. Other species used in those early plantings which not only survived but which have thrived are still our guide in the selection of species for present use.

Included in the early plantings but not used today because of lack of survival, poor growth or excessive loss due to insects and disease, are spruce, arbor vitae, Japanese red and black pine, and Scotch pine. Other conifers including red, white and jack pines, used in those initial plantings are three of our standbys today. Among the deciduous species used, black locust is no longer planted in pure stands because of the depredations of the locust borer. It is, however, used regularly as a part of a mixture of other deciduous trees for the benefit that those trees will derive from the nitrogen fixed by the locust. Tulip poplar, black walnut, chestnut oak and red oak still form an important part of our planting mixtures, catalpa being the only deciduous tree used in those early plantings that has since been dropped.

Technical Direction Provided

By 1939 the revegetation program had assumed such proportions that the Association then employed a director of conservation to have charge of that work. By then the early plantings had begun to show promise of producing future timber crops. The companies were interested in expanding their effort to cover a larger territory and required the services of a technical man to see that the program was properly executed.

This program of reforestation, which had initially been looked upon by practically all the open cut mine operators as purely a defensive measure to cover the mined lands and keep down adverse public opinion, actually showed definite possibilities of becoming a sound economic undertaking. The Indiana Farm Bureau had become interested in the results of the plantings and the possibilities for producing future timber crops from this land, most of which had been submarginal for agricultural purposes before it was mined. The Indiana Department of Conservation saw the possibilities of future timber production and various forms of public use.

Law Aids Program

In 1941 representatives of the Indiana Farm Bureau, the Indiana Department of Conservation and the Indi-

ana Coal Producers Association drafted a bill which was enacted into law that requires each and every open cut coal mining operator in the state to revegetate an area equal to 101 percent of the land which they mined each year.

This law does not specify what shall be planted but states that the area shall be revegetated with grasses, trees or shrubs. The administration of the law is under the jurisdiction of the Department of Conservation. That department has been very much interested in seeing the mined lands restored to their highest form of use, whether it be grasses or trees. The state forester's office cooperates in the selection of the planting sites and approves planting plans for each tract before work is undertaken. Areas to be seeded for pasture are selected in accordance with recommendations made by the agronomy departemnt of Purdue University and seeding mixtures recommended by that department are used.

Planting Site Selection

The selection of sites to be covered in the revegetation program is a perpetual job. It is one that requires constant field observation as well as the use of accepted methods of determining the pH of the areas and the amounts of phosphate and potash available for plant growth. The time required before trees can be successfully established on mined land varies a great deal with the type of material exposed during the mining operation. It ranges from as little as two winters to permit settling of the material and the establishment of waterways, to as much as ten or twelve years (in a few cases longer) where areas contain a large percentage of hard rock or shale or where pyritic material is present in sufficient quantities to establish a pH toxic for the growth of vegetation.

Three years of intensive field study and laboratory tests led Edward N. Stiver of the Department of Agronomy of Purdue University to conclude that a pH of 3.5 and below was too acid to permit the establishment of any vegetation on these lands.

The Central States Forest Experiment Station has found that little or no plant growth is possible with a pH of less than 4.0. The findings of these two investigations together with the physical characteristics of the areas, serve as our guide in the selection of sites for revegetation.

Selection of sites on which seedings are to be made for pasture purposes is more exacting than for the establishment of trees. In his three years of work Stiver found that an area to be seeded for pasture purposes should have a pH of 7.0 or above. The determination that an area has the necessary high pH as well as the

Figure 3. Man-made lake in final cut of mining operation, Clay County, Indiana. Pines along bank planted in 1934 and 1936.

amount of potash and phosphate available to sustain a stand of grasses and legumes requires careful detailed sampling of the area.

Results of Forest Planting

As previously mentioned many of the earlier plantings have reached the point where they show a great deal of promise of producing valuable crops of forest products. Plantations of pines including jack, red and white pines, established between 1926 and 1934, are large enough so that crops of fence posts, mine props, small poles, pulpwood and some small saw logs could be harvested from them. Those trees have reached an age where they are all reproducing themselves throughout the entire area of the old plantations. (Figure 2.) Jack pine which normally produces viable seed at an early age has established reproduction which is now 18 feet in height and three inches in diameter. This second generation from the original plantings is now producing viable seed. Red pine which according to opinion would not reproduce in this climate nevertheless has shown an ability to do so. The largest natural reproduction of red pine is now over five feet in height and there are thousands of smaller specimens in the same areas. White pine has just begun to establish natural reproduction, the oldest seedlings found so far being three years old. Virginia and pitch pines which have come into general use only within the last ten years are just now beginning to establish seedlings.

The earliest plantings of deciduous species were limited mainly to black locust with a few interplantings of tulip poplar, black walnut, chestnut oak and red oak. Most of the stands of black locust have gone the way of the majority of locust plantings in southwestern Indiana. Many are so badly riddled with black locust borers that the locust themselves will never produce any wood crop. In areas where other deciduous species were planted with them or where they came in voluntarily the growth of those species is far in excess of their growth when not associated with the locust. Tulip poplar planted in association with black locust in 1926 now exceeds ten inches in diameter and is over 50 feet in height. Black walnut, chestnut oak and red oak have produced stems six to eight inches in diameter in that same period of time. Volunteer cottonwood and sycamore which seeded in about that same time have produced trees more than 16 inches in diameter. On one area mined in 1928, now a portion of the Greene-Sullivan State Forest, the state harvested a crop of cottonwood pulpwood in 1946. Numerous trees cut in that operation had butts too large to be easily split to meet pulpwood requirements. These butts were cut into eight and ten foot logs and marketed to a local mill.

Topography

Because of the nature of the mining operation the topography of the areas is rough, consisting of more or less parallel ridges or high mounds. When first laid up these areas are raw. They are devoid of all forms of vegetation and support little or no animal life. Given a few years, nature rounds off these peaks and begins filling the valleys. Internal erosion, practically none of which leaves the area to deposit silt in the streams or to add to flood crests, begins its process of regrading these tracts. Water which falls on the steep slopes, if not absorbed by the porous material finds its way into the internal valleys where it is absorbed and fed gradually into the lakes usually formed by the final cuts of the mining operation.

Practically all of these man-made lakes are ideal for the growth of aquatic plants and for the species of fish native to Indiana. These lakes of clear clean water in a section of the country where the streams are usually muddy and often polluted form the only bodies of water suitable for healthful recreation in the area. (Figure 3).

Unless the material in the areas is toxic to plant growth a fringe of weeds will appear in two or three years. Forestation usually follows close on the appearance of this vegetation, which is a far better index of plantability than soil tests alone. Within a period of five to ten years these areas, once raw and uninviting, usually support a stand of vegetation which causes them to lose their identity as areas which had been mined. Too often the casual observer sees only the raw, unrevegetated areas and, intentionally or not, fails to give credit for the areas on which work has been completed and which have been returned to productive use.

Target of Prohibitive Legislation

Even though the program here in Indiana has successfully revegetated approximately two out of every three acres which have been mined from the beginning of open cut mine operations down through the years to June, 1947, and the job is going ahead at an accelerated rate, the industry is usually singled out at each session of the legislature and bills are introduced which would require the industry to regrade the areas, often to the extent of restoring the original contour. Others include professional do-gooders who perhaps seek to get their name in print; individuals who through lack of information believe that to be the proper way of handling the land; and unscrupulous persons who promote these bills with a thought of "shaking down" the industry.

There does exist a small fraction of the area mined that with the necessary grading and some other preparation again could be devoted to row crops. It is however, no more logical to assume or to require by law that all

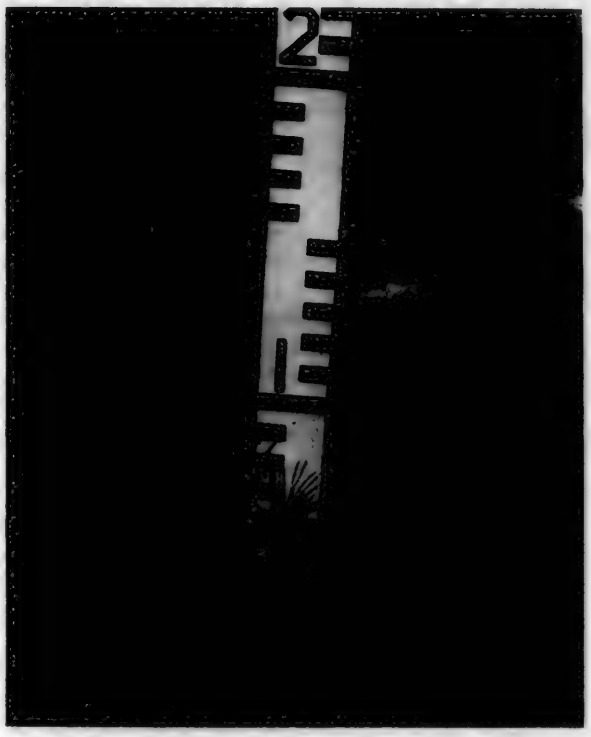

Figure 4. Virginia Pine planted in March, 1945, on levelled area of mined land in Vigo County, Indiana.

of these areas be treated in the same way than it would be to require that all land now in farms be treated the same and that every acre of farmland be operated under the same crop rotation.

Grading Usually Detrimental

Various experiments are being carried on by the operating companies in the mid-western states to determine the most economical and the most practical way of placing mined areas in their highest form of use. Some areas have been regraded and planted to trees or grasses. Others have received different degrees of treatment ranging from striking off the ridge tops to a width of eight to ten feet, to carrying the strike-off to a point where the areas are gently rolling. While serving as a member of the Land Use Advisory Committee of the National Coal Association I have visited the important mining areas from Oklahoma to Alabama and Pennsylvania. That committee has visited all types of reclamation and has seen all different kinds of treatment. We have seen grading operations on these mined areas to restore them to approximately their original contour which have cost from a minimum of $65 an acre to a maximum of $1,400 an acre. By far the majority seen to date has ranged between $300 and $500 per acre. In only one territory have we seen areas which had been graded where the result of that work was beneficial to the growth of vegetation. In most instances it had been detrimental. That one exception, where coal was being removed in long narrow strips winding around the contour of the hills, stands out. There was very little rock and the other material over the coal was of such a nature that it did not compact readily. It was high in available lime and other plant foods. Here the grading had created the only semi-level land in the community, land which was producing excellent crops of forage.

Contrasted with this one successful exception are the numerous other instances in which the rehandling of the material beyond making a single, narrow swath down each ridge, proved to be a disadvantage from the standpoint both of establishment and growth of vegetation. Virginia, Jack and Pitch pines were planted on levelled and unlevelled areas in Indiana in March, 1945. In August, 1949, the survival of the trees on the levelled areas was less than twenty-five percent while on the unlevelled areas it exceeded eighty percent. The difference in growth was even more pronounced, ranging from less than one foot on the levelled portions to over six feet on the unlevelled. (Figures 4 and 5.)

From the standpoint of erosion grading has been

(*Continued on page* 170)

Figure 5. Virginia Pine planted in same row and on same day by same man as Pine shown in Figure 4, except on unlevelled mined land.

A Report from the United Nations Scientific Conference on Resources

R. D. HOCKENSMITH

The United Nations Scientific Conference on the Conservation and Utilization of Resources held at Lake Success, New York, August 17 to September 6, 1949, was devoted to an exchange of ideas and experience on the techniques of resource conservation and utilization, their economic costs and benefits, and their inter-relations. The conference had no policy-making responsibilities; it did not bind governments nor did it formulate recommendations to them. In other words, it was scientific rather than policy-making. Individuals who were invited to contribute papers to the conference included scientists, engineers, resource technicians, economists and other experts. They participated as individuals and not as representatives of their governments or organizations. About 600 participants and observers from 49 countries were present.

The conference met on 15 days during the period August 17 to September 6, 1949. Plenary meetings were held on the first two days of the conference, the succeeding 11 afternoons and on the last two days. Section meetings were held on the 11 mornings beginning on the third day of the conference. On the mornings devoted to section meetings, five sections met simultaneously.

Languages of the conference. The business of the conference was conducted, by means of simultaneous interpretation, in the two working languages of the United Nations, English and French, and in the official languages, Spanish, Russian and Chinese, as far as necessary to accommodate conference participants.

Conference method. Most papers for plenary meetings were read in full, except in those instances where symposia were organized. Papers for section meetings were not read verbatim although the complete text was available to all participants. This allowed maximum time for full discussion by the participants of the subject of the meeting.

Conference record. The text of the papers presented at the conference, together with summaries of the discussion at the sessions, will be published (probably about January 1950) in order that the proceedings may be more widely available to the governments and peoples of the United Nations.

Field trips and films. A program of field trips was arranged in conjunction with the conference, held on weekends and immediately following the conference. A special film program covering the subject matter of the conference was arranged from selected films produced in the participating countries.

The conference agenda. Specific attention was given to the *"inter-relations" of resource techniques.* In order to promote the common consideration of related problems, approximately half of the program was given to plenary meetings on subjects of general interest to scientists, technicians, economists and resource administrators, whatever their special field.

Beginning with a statement of the world's legacy of the depletion and misuse of resources, the plenary meetings dealt with the contribution of improved techniques to the alleviation of shortages of mineral resources, fuels and energy, and food and forest products. A series of meetings was devoted to the resource techniques of particular importance to the less developed countries. The plenary meetings concluded with a review of the experience in various nations with propects based on the coordinated application of resource techniques.

Ample opportunity was given to specialists to exchange methods and experience with respect to specific problems and techniques. Accordingly, half of the conference program was devoted to more specialized section meetings. These section meetings were devoted to the discussion of techniques for the conservation and utilization of the following resources: Minerals; fuels and energy; water; forests; land resources; and wildlife and fish resources. These section meetings highlighted particular techniques which have practical application to the job of extending the supply of resources, either by conservation or by rendering usable previously economically unusable resources.

Throughout the program particular emphasis was placed on the adaptation of techniques required for areas of different climatic and physical land conditions and of varying degrees of economic development. The attention of scientists and technicians was thus called to the prob-

R. D. Hockensmith was invited by the Secretary-General of United Nations to be one of the several participants from the United States at the United Nations Scientific Conference on the Conservation and Utilization of Resources. Mr. Hockensmith is Chief, Soil Conservation Surveys Division, Soil Conservation Service, Washington, D. C.

lems and potentialities of those regions of the world which have thus far not been subjects of intensive study. This was of particular value to those planning the development of under-developed areas in helping them to avoid the mistakes in resource use and the waste that have so often characterized the development of the older industrial nations.

The spirit of the conference was one of sharing scientific techniques. The personal contacts made by the participants during the conference will enable them to know whom and where to ask for help in different fields.

In the meetings of the Land Section there was considerable emphasis on the need for land and water inventories as a basis for developing sound programs of land use and conservation.

It was pointed out that we must put our present knowledge to work in conserving and utilizing our resources and not sit back and wait for a new source of energy.

The topics discussed at the Plenary meetings were:

1. The World Resources Situation
   a. The legacy of resource depletion
   b. The increasing pressure on resources
   c. A world review of critical shortages
      (1) Food
      (2) Forests
      (3) Minerals
      (4) Fuels and energy
2. Using and Conserving Resources
   a. Interdependence of resources
   b. The complementary nature of European resources: A basis for developing regional economic cooperation
   c. The planning of land-use for full production, with special reference to European conditions and the national planning undertaken in the United Kingdom
   d. Soil and forest conservation and the protection of water supplies
   e. Techniques for increasing agricultural production
   f. Estimates of undiscovered oil and gas reserves
   g. Economics of competitive fuels for various purposes and their use to meet future fuel requirements
   h. Metals in relation to living standards
   i. Conservation of mineral resource
3. Creatable Resources: The Development of New Resources by Applied Technology
   a. Fodder yeast and algae
   b. The contribution of chemurgy
   c. Wood fiber
   d. Food yeast in the British Empire
   e. On fat synthesis by micro-organisms and its possible applications in food industry
4. Methods of Resource Appraisal
   a. Resource surveys
   b. Statistical tools in resource appraisal and utilization
5. The Adaptation of Resource Programs
   a. The assessment of conservation programs
   b. Application of simple conservation and utilization practices
6. Assessing Resources in Relation to Industrialization Plans
7. Education for Conservation
8. Resource Techniques for Less Developed Countries
   a. Training of technical and scientific personnel in the less developed countries
   b. Symposium on resource techniques of special interest to less developed countries
   c. Techniques in the recruitment and training of labor
   d. Public health techniques
9. The Integrated Development of River Basins—The Experience of the Tennessee Valley Authority
10. The Integrated Development of River Basins—A Symposium on Public Policy
11. A Symposium on Future Lines of Study and Directions for Progress
12. The Use of Resources for the Enrichment of Human Life
13. The Contribution of the Conference to the Continuing Work of the United Nations

The topics discussed in the Land Section were:

1. Methods of Soil Conservation (7 papers)
2. Soil Conservation—Organization and Evaluation of Programs (10 papers)
3. Soil Surveys—Research in Relation to Soil Conservation (10 papers)
4. Aids to Farming (9 papers)
5. Improving Soil Productivity (12 papers)
6. Seeding and Restoration of Natural Grazing Lands (7 papers)
7. Protection of Crops and Grassland (9 papers)
8. Opportunities for the More Effective Use of New Agricultural Lands (12 papers)
9. Condition of Grazing Lands (7 papers)
10. Plant Breeding (10 papers)
11. Livestock Diseases and Pests (7 papers)
12. Crop Policy and the Feeding of Livestock (6 papers)

The topics discussed in the Water Section were:

1. The appraisal of water resources

(*Continued on page* 180)

Recent Research Reviews

JAMES H. STALLINGS

The Reviews by J. H. Stallings that follow are a regular feature in the JOURNAL. It is hoped that the projects reviewed from time to time will be helpful to conservationists everywhere. Members of the Society are urged to indicate their interest in the kind of research work that should be reviewed.

Cover Crop and Sod Plus Mulch Orchard Soil Management. *By* C. W. ELLENWOOD *and* T. E. FOWLER; *Ohio Agr. Exp. Sta. Bul. 672, Wooster, Ohio, Nov. 1947.*

A record of the behavior of an apple orchard of Delicious and Stayman Winesap for a period of 30 years is presented. Two systems of orchard soil management, cover crop and mulch, are compared.

At the end of 30 years, there was no significant difference in the size of the trees on the two plots.

The method of culture had no effect on the average date of full bloom.

The frost penetration of the soil during severe winters was much less under the mulch than the cover crop system.

The Stayman trees on the cover crop plot produced more fruit per tree during the 30-year period than those on the mulch plot. Conversely, the Delicious trees were slightly more productive on the mulch plot. During the period from the twenty-first to the thirtieth year, the average annual production of Stayman per acre on the cover crop plot was 499.2 bushels and on the mulch plot 406.7 bushels. During this same period the Delicious produced at the rate of 370.6 bushels on the cover crop plot and 456.2 bushels on the mulch plot.

The average yield per acre for the 10-year period 1935 to 1944, for both soil treatments and both varieties, was 433.1 bushels. For the 10-year period 1925 to 1934 it was 327.8 bushels per acre.

The size of the fruit of both varieties was larger on the mulch plot than on the cover crop plot. This was particularly true in the case of Stayman; however, the larger individual fruits from the mulched Stayman trees did not compensate for the lower yield.

Both varieties of fruit from the cover crop plot were more highly colored, though only slightly, than from the mulch plot.

For the 30-year period, the cost of producing a bushel of apples up to and including grading expense was .560 cents on the cover crop and .581 cents on the mulch plot. It is doubtful whether this difference of 2 cents per bushel in growing cost is significant.

Spraying was the largest single item of expense on both plots. Harvesting expense ranked second on the cover crop plot and soil management charges third. On the mulch plot, soil management expenses ranked second in importance and harvesting costs third.

During the last 20 years of this 30-year period, the only years when weather conditions seriously depressed the yield were in 1927 when frost reduced yields and in 1939 and 1943 when Delicious did not set normal crops.

The average annual value of the fruit per tree on the cover crop plot was $12.69 as compared with $12.27 on the mulch plot.

Producing Wildlife by Good Farm Land Use. *By* R. G. HILL *and* G. W. BRADT; *Agri. Ext. Service Extension Bul. 218 East Lansing, Mich., June 1948.*

The farm woodlot is one of the most important wildlife habitats on the farm. A well-managed woodlot is a distinct economic asset and may contribute as much to farm income as does a similar acreage of crop or pasture land. Good forestry practices in woodlots are in general also good wildlife practices. The grazing of farm woodlots is usually disastrous to forest reproduction, and is questionable from an agricultural viewpoint because of the comparatively low forage value of woodlot pasturage, and the difficulty in controlling animal disease in shade. The elimination of wildlife cover by grazing is so pronounced that some kinds of wildlife disappear within a few months after the invasion of livestock into a woodlot. According to the 1935 Census, 75 percent of all farm woodlots in southern Michigan are pastured. The devastating effect of this situation upon the population of rabbits, quail, grouse and pheasants in some areas is not fully appreciated.

Tile Effluent Measuring Devices. *By* WILLIAM W. DONNAN *and* GEORGE B. BRADSHAW; *Agr. Eng., Vol. 30, No. 3, pp. 134-136 and 140, March 1949.*

The authors adopted the tile-effluent measuring stick and continuous-flow recorder in an attempt to (1) calibrate a device for getting approximate, instantaneous flows from 4-in., 6-in., and 8-in. tile outlets under normal conditions and (2) build a portable device for recording flows from tile outlets through irrigation cycles or for short periods of time. This report details the work done to date on these two devices.

Report on Sedimentation in Lake Corpus Christi and the Water Supply of Corpus Christi, Texas. *By* CARL B. BROWN, VICTOR H. JONES *and* ROSS E. ROGERS; *USDA, SCS-TP-74, Fort Worth, Texas, December 1948.*

A preliminary examination of Lake Corpus Christi was made on February 18-20, 1941, which indicated an unusually high-rate of capacity loss and the probability that insufficient storage would remain in the lake after a short period of years. This was followed up by a detailed sedimentation survey of the reservoir and a study of the problems of future water supply. A complete new survey was made during the winter of 1947-48.

This report contains the final results of the survey made during the period January 15-May 15, 1942 and the survey made during the period of February 2-March 21, 1948. It was found that 10,625 acre-feet of sediment accumulated in the reservoir in the 7.6 years since July 23, 1934 and that the total capacity loss to 1942 was 19.52 percent, and the average annual rate of loss was 2.57 percent. On March 1, 1948 the reservoir had a capacity of 39,387 acre-feet as a result of deposition of 4,414 acre-feet of sediment in 6 years since the 1942 survey. Its capacity had been reduced 27.63 percent by March 1, 1948, and the average annual rate of loss for the 13.6 year period was 2.03 percent.

Some Influences of Frost Penetration on the Hydrology of Small Watersheds. *By* F. R. DREIBELBIS; *Amer. Geo. Union Trans., Vol. 30, No. 2, pp. 279-282, April 1949.*

An example of the influence of frost penetration on hydrologic as well as agronomic problems is presented and discussed. The data indicate frost penetration retards percolation thereby retaining water in the soil profile that normally would drain. Frost penetration through its influence on percolation and resultant available storage may affect infiltration for a considerable time after the frost period.

Roadside Erosion Is Preventable. *By* F. W. CRON; *USDA, Public Roads Administration, Gatlinburg, Tennessee. Paper presented at the Annual Highway Conference of the University of Tennessee, Knoxville, Tennessee, April 29, 1949, Mimeographed.*

Ditch and shoulder maintenance is one of the costliest and most troublesome operations of highways. In one state, material removed from the ditches varied from 220 to 720 cubic yards per mile with an average of 370. One eastern county reported costs from $300 minimum to as high as $800 per mile. In both cases efficient modern machinery was used for the work wherever possible.

Costs such as these represent in the aggregate enormous expenditures which are not "self-liquidating." In some cases these operations actually result in the destruction of the little protection Nature has been able to provide unaided.

It is possible to design and build highways with roadsides so stable that the ditches seldom need cleaning. Erosion control should be built into the highway by beginning with the original location and design. The drainage must be adequate and all bare earth protected in some degree from falling and running water. Stabilization of the slopes is as important as handling and disposing of surface water after it reaches the roadway. To date no one has found a practical substitute for vegetation as a means of furnishing this protection.

Erosion caused by falling raindrops is probably the most destructive of the agents causing erosion on highways. The right vegetative cover will prevent most of the damage caused by the action of erosive agents and will keep the soil on the slopes and out of the ditches and gutters. Local plants should be used as much as possible for stabilizing slopes. Mulch is a common denominator for all stabilizing treatments.

Supersonic Methods Short-Cut Reservoir Silt Measurements. *By* CHARLES W. THOMAS; *Civil Engineering, Vol. 19, No. 5, pp. 43-47, May 1949.*

High-frequency echo-sounding equipment is standard for depth measurements, and several electronic instruments are being tried out for coordinating quickly the horizontal location of the soundings. The author challenges engineers further to develop supersonic sounding equipment to measure depths of silt directly as well as to explore the behavior of density currents.

Effect of Timber Cutting on Water Available for Stream Flow from a Lodge-Pole Pine Forest. *By* H. G. WILM *and* E. G. DUNFORD; *USDA Tech. Bul. No. 968, November 1948.*

Detailed investigations were started in 1938 on a group of twenty 5-acre plots in a forest of mature lodgepole pine near Fraser, Colo. For 2 years records were taken of snow stored on the ground in the uncut forest before melting started each spring; of the length of time required for the snow to melt; and of the amounts of precipitation reaching the soil through the forest canopy. Then, in 1940, 16 of the plots were cut over by selective cutting methods. Since the plots were arranged in 4 randomized blocks, each of 4 cutting treatments and an uncut plot were assigned to each block. All trees larger than 9.5 inches in diameter were removed from one plot; three of the remaining plots were cut over to leave 2,000, 4,000 and 6,000 board feet of merchantable timber per acre; and one plot was left uncut as a check. Supplementing these main treatments, one-half of each cut-over plot was subjected to additional treatment for timber-stand improvement, which removed undesirable trees from the reserve stand.

After treatment several components of water yield

were measured over a period of 4 years (1941-44) to show the influence of timber cutting on the disposition of precipitation. Initial snow storage—the water content of snow before any water was released to the soil by melting—was sampled by a survey of all plots about March 15 each year. The progress of melting was then followed by means of repeated weekly surveys, continuing until the snow had disappeared from all the plots. During the snow-melting period and throughout the summer, rain-gage records indicated how much precipitation reached the snow or soil through the forest canopy under each timber-cutting treatment. And finally, detailed records of soil moisture were obtained each autmun to measure the integrated effects of transpiration, evaporation, and precipitation during the summer upon soil-moisture deficients.

By these methods of study exhaustive records were obtained on all important phenomena involved in the disposition of the precipitation as affected by timber cutting, with the exception of evaporation from the stored snow. While this component could not be measured directly on the plots, records of snow evaporation were obtained from a large stationary pan, and with these data as a base reasonable estimates were made of snow evaporation on the plots.

In addition to these quantitative data on factors associated with water yield, observations were made to show the effect of timber cutting on the forest environment and especially on soil erosion. These were checked and amplified by inspection of recent and older timber-sale areas at a number of places in the lodgepole pine type.

Effect of Grass on Intake of Water. *By* F. L. DULEY *and* C. E. DOMINGO; *Neb. Agr. Exp. Sta. Research Bul. 159, April 1949*

Infiltration tests were made on a number of grass land soils by means of a 16- by 72-inch sprinkler type infiltrometer. Tests were made on native meadow and range pasture land in a moist subhumid to dry subhumid climate.

The various types of grasses tested were effective in inducing a high intake rate of water into the soil. However, the total cover, including live grass and associated litter, was more significant than the kind of grass or the type of soil.

Chips on the Land. *By* ROBERT A. SCHRACK *and* L. RUSSELL ALBRIGHT; *American Forests, pp. 16-17 and 38, May 1949.*

The authors described a portable wood-chopping machine which is capable of grinding tree tops, limbs and other waste material into chips. These chips can be used to enrich the soil, mulch strawberries, or to perform countless other useful functions around the farm.

The Use of Mined Land

(Continued from page 165)

devastating. When a large area of this exposed material is regraded either to approximately the original contour or in the form of a plateau, a problem of water disposal is created. The machinery working back and forth over the area in the grading operation apparently compacts the material to the point where only a small fraction of the rainfall is absorbed. Tests carried on by the Central States Forest Experiment Station show that the rate of infiltration on levelled materials was only .6 inches per hour while on adjacent unlevelled areas the rate of infiltration was 3.9 inches per hour.

The rainfall that is not absorbed either collects in depressions and creates puddled flats where little or nothing will grow, or concentrates in channels and begins to cut gullies down the slopes. This concentration and the resultant gullying carries enormous quantities of silt out into the adjacent land and into the streams. Another important condition is caused by the grading in some types of material. On areas where there is a concentration of pyritic material it usually occurs in spots varying in size from one or two feet across to entire ridges or portions of them. Two such areas where extensive grading had been carried on have been observed, one in a sandstone material, the other in a clay shale. In both instances the result had been the same. During the grading operations the acid-bearing materials had been so completely mixed with the remainder of the material in the area that the entire tract was toxic to all plant growth. On the sandy area the graded ridges after four years time were 60 percent plantable, while the entire graded area was, because of the acid condition, unplantable.

Facts, Not Sentiment

The question of whether these areas should be revegetated as left by the mining operations or whether their topography should be further altered becomes a question of economics as well as of sound land use. If trees, grasses or legumes will grow as well or better on the areas as they are left by the mining operation the owners of the land should not be urged or required to invest additional capital in them if that investment will not increase their productivity.

It is our policy to place these surface-mined lands to their best use based on the results of competent research directed by state and federal agencies. There have been changes in the revegetation program directed toward the future use of these mined areas in the past. Additional changes will be made just as rapidly as competent research and experimental work shows that those changes are economically sound.

BOOK REVIEWS

GROWTH OF PLANTS. *By* WILLIAM CROCKER. *Reinhold Publishing Company, New York. 1948. $10.00.*

Plant scientists will find the twelve chapters of "Growth of Plants" brimfull of brilliant research summaries from the Boyce Institute's twenty years of truth seeking.

Chapter headings are as follows: Early Problems, Life Span of Seeds, Dormancy in Seeds, Physiological Effects of Ethylene and Other Unsaturated Carbon containing Gases, Effect of Certain Lethal Gases upon Plants and Animals, Plant Hormones, Dormancy in Buds, Plant Cell Membranes, Plants Grown Under Controlled Environments, Research on Insecticides, Fungicide Investigations and Miscellaneous.

The author, William Crocker, Managing Director, Boyce Thompson Institute for Plant Research, Inc., New York, says that this book is a critical summary of researches carried on at Boyce Thompson Institute. Only such outside researches are discussed as are necessary to orient the work at the Institute generally in the whole field of plant science.

This book is written by scientists for scientists. Considered as a scientific book it is well written and clear. The trade terms of the scientist are used throughout. Much of the material will have to be interpreted by middlemen before it can be absorbed by the country trade. There are 459 pages, 171 having excellent illustrations and charts which add greatly toward interpreting the text. Part of the illustrations are in color. Some of the micro-photography can be classed as innovations in that field.

This book contains so much new material that scientists must read it if they are to keep up with the advancing tide of information. The book isn't "night cap" reading, but the reward for digging into it is there for those who are interested in solid science.

—B. W. ALLRED, *Fort Worth, Texas*

SOIL PHYSICS. *2nd edition. By* L. D. BAVER. *John Wiley and Sons, New York. 398 pp., illus. $4.75.*

This new edition of Baver's well-known book on soil physics covers a field fundamental to conservation in a comprehensive manner. It brings the work abreast of new advances in research, in both the pure and applied branches.

The organization of the book lays emphasis on topics basic to soil management. After a brief discussion of soil texture, the author analyzes the role of soil colloids, describes the features of consistency and structure, and explains the dynamics of soil water, air, and temperature. There is a balanced presentation of both fundamental theory and practical aspects of the subject. The book concludes with two chapters relating the physical properties of soils to tillage and to runoff and erosion.

While recent findings in conservation research are given a prominent place, the historical background of the various concepts is not neglected. Many practicing conservationists may be surprised to learn how early in the preceding century some of the so-called modern ideas were recognized; as, for example, the role of microorganisms in the soil, and the forces of raindrop impact.

This will be a useful addition to any conservationist's workshelf.

—BEN OSBORN, *San Angelo, Texas*

FREEDOM FROM WANT. *Edited by E. E. deTurk. The Chronica Botanica Co., Waltham Massachusetts, and Stechert-Hafner, Inc., New York, 1948. Pp. 78. Price, paper bound, $2.*

This is a highly important publication in which H. R. Tolley, Robert M. Salter, K. S. Quisenberry, F. B. Morrison, John D. Black, and M. A. McCall survey the possibilities of meeting the world's food needs. The subjects discussed are: population and food supply, world soil and fertilizer resources in relation to food needs, crop production potentialities in relation to freedom from want, animal production in an efficient food economy, the economics of freedom from want, and obligations of science toward freedom from want. The papers were presented as a symposium at the meetings of the American Association for the Advancement of Science at the Boston meeting in December, 1947. A great deal of thought has gone into their preparations, and the authors have given the readers plenty of material for study and thought. The publication constitutes Volume 11, number 4, of Chronica Botanica.

—FIRMAN E. BEAR, *New Brunswick, New Jersey*

RAINFALL AND RUNOFF. *By* EDGAR E. FOSTER. *Macmillan Co., New York. 1948. 487 pp., illus. $9.00.*

This book presents a rather complete picture of surface hydrology as affected by rainfall and runoff.

Much progress has been made in the past 15 years on surface hydrology in the field of engineering, meteorology, geology, and other related sciences. This information has been well assembled and presented in this book.

The statistical analysis method as introduced in this book is a deviation from the long recognized methods of computing runoff by a few empirical formulas using exact mathematics. The presentation of actual charts,

diagrams, and related data showing results of statistical analysis is very good.

The author has shown how snow surveys, studies of air masses and their movements, evaporation, rainfall intensities, and frequency affect the rate and amounts of runoff.

The book contains an unusually large number of charts, graphs, diagrams, and tables that help to illustrate methods and procedures. These charts are not representative of any particular area in the United States, but rather give a coverage of the whole, which makes the book more valuable to a larger number of people.

—JACK A. GRIFFIN, *San Angelo, Texas*

THE COMING AGE OF WOOD. *By* EGON GLESINGER. *Simon and Schuster, Inc., 1949. 269 pp. with index and graphic illustrations. $3.50.*

In his book "The Coming Age of Wood," Egon Glesinger presents a plan of global forestry—for both the growing of trees and the manufacture of the derived products. The volume, an optimistic preview of the future of wood, gives one a peek behind the scenes at the many new cellulose and lignin products that might be with us when economics make their production possible.

The book is in three sections. Part One surveys the world's forest resources, which cover one fourth of the earth's land area. In this interesting historical resume, the wood supply problem is posed and a solution outlined for attaining an economy of plenty. Europe, Asia and the United States are examined in detail with respect to availability of resource and plans for its maintenance. The author lingers on the 5,000 million acres of virgin forest left in tropical and subtropical regions of Africa and Latin America and in Alaska. Manchuria and Siberia—the last exciting frontier left to man.

Part Two is a graphic presentation of the technical aspects of timber growth and wood utilization. Fifteen colored charts by artist Henry Billings tell the fascinating story of "How a Tree Works," "What is Wood," "The Nature of Wood," "Waste in the Forest," "Industrial Waste," "Integrated Forest Industries" and other subject matter.

Some of the statistical chart information presented with respect to waste might be questioned. For instance, under "Waste in the Forest" Glesinger states that the "veneer logger . . . takes only the butt end of the stem and abandons more than two thirds of the tree." In the Douglas fir plywood industry, at least, the logger also brings in the other logs. They are sold for sawlogs or traded for peeler logs or are used for inside veneers in plywood under the increasing standards of utilization prevailing waste figures might also be questioned.

In Part Three each major product or process of the forest industries is surveyed and given its role in *The Coming Age of Wood*. Included are wood sugar, lignin, plastics or reconstructed wood, wood alloys, tree chemicals, cellulose for pulps and wood gas. A full chapter is devoted to integration as the solution to elimination of wood leftovers—coordinating or grouping lumber, plywood, pulp and other mills on one site and drawing raw material from one central supply to recover every atom of wood profitably.

Glesinger's appraisal of the forest supply situation in the United States is basically a reprint of Miscellaneous Publication No. 668 published by the U. S. Forest Service and is therefore one-sided and questionable as to accuracy of data used. It gives the solution to permanent forest management as being "immediate federal legislation and control" and reiterates the well-known philosophies of the centralized control planners.

The author is also inconsistent. He admits in several parts of his book that the "virgin forest is static" and that decay balances growth. Yet he states that in the northwest "These last virgin forests—which took 500 years to grow—are being butchered." Foresters know that virgin forests must be harvested to get new growth on the land.

Glesinger also minimizes the role of industrial forestry in the nation's economic structure and passes off 18,000,000 acres of privately owned tree farm lands with two uncomplimentary sentences. On his next trip to the United States, he should inspect the real progress being made by these landowners, surpassing the much extolled record of the federal agency to which Glesinger pays tribute.

Although the section on products to be derived from wood is fascinating reading to the layman, it should stress even more the fact that a market must first be found for all the new products developed. The one industrial alcohol plant on the Pacific Coast, for instance, in today's economy is manufacturing a nonprofitable item from waste sulphite liquor. The alcohol—from wood—waste plant has been largely inoperative because of unsolved technology and a low price market for the alcohol product.

Glesinger in his chapter on integration berates the wicked lumbermen and pulp manufacturers for not getting together on raw material supply. The sawmill economy on the Pacific Coast is based on Douglas fir and pine species. The leftover sound wood from these mills is suitable only for Kraft pulp. Until recently, all the major producing pulp mills in the same region have been sulphite mills, using western hemlock and spruce. There just was no getting together! The lumbermen and pulp men, therefore, had to develop separate log sup-

plies. Until Kraft pulp came to the south, the same condition existed there. Glesinger creates the impression that most of the material unutilized in forest and mill is deliberate waste, willfully created. It is, instead, a condition created by unfavorable economics of hauling and disposal and unavailability of markets.

Glesinger, who also wrote the wartime volume *"Nazis in the Woodpile,"* is Chief of the Forest Products Branch of the Food and Agriculture Organization of the United Nations. He was Secretary General of the Comite International du Bois (CIB) from 1933 to 1946, before joining FAO.

—ALBERT ARNST, *Tacoma, Washington*

DYNAMICS OF VEGETATION. *Selections from the writings of* FREDERIC E. CLEMENTS, *compiled and edited by* B. W. ALLRED *and* EDITH S. CLEMENTS. *296 pp., illus., H. W. Wilson Co., New York, 1949. $3.75 per copy.*

The basic and highly valuable contributions made by the late Frederic E. Clements in the field of ecology should be familiar to every ecologist. There has often been disagreement with his terminology, and with some of his ideas as well, but there can be no question but that the effect of his thinking and work will be felt for generations.

Clements' writings were voluminous. They sparkle with ideas. They offer food for thought to any ecologist seeking to unravel the meaning behind the plant, animal, and human activities affecting the life of a community. And, up to now, they are scattered in many publications, some of which are commonly available only in larger libraries.

Fortunately for present as well as future ecologists, Bernhard Hoffman of Santa Barbara suggested the desirability of a publication that would bring together in one volume the essence of what Clements had to say. Fortunately also, B. W. Allred and Edith S. Clements took up the suggestion and did something about it. They have edited and issued a volume that belongs on the bookshelf of every person who is or hopes to be an ecologist, and that ranks as a classic in anyone's vocabulary.

The title *"Dynamics of Vegetation"* is an apt one in view of Clements' dynamic concept of the community. He was one of the foremost among ecologists to develop the dynamic, as opposed to the static concept. The book consists of 296 pages, is copiously illustrated with 69 plates, and is well-indexed.

This reviewer would have preferred to see a complete bibliography of Clements' work as an appendix. He would recommend strongly that this be considered in a later revised edition. The "supplemental references" list in the present volume offers a clue to Clements' bibliography, containing 11 major publications, two of which are not Clements'.

Even so, the cream of Clements' prolific career has been put together in a book that is a library in itself. Ecologists, land use specialists, range men, foresters, conservationists, biologists—whether teaching or engaged in action programs—cannot possibly afford to do without the *"Dynamics of Vegetation"* unless they own all of Clements' major works.

—WILLIAM R. VAN DERSAL, *Portland, Oregon*

GARDEN SOILS, THEIR USE AND CONSERVATION. *By* ARTHUR B. BEAUMONT. *Orange Judd Publishing Company, Inc. 1948. $3.50.*

In the foreword, the author states that the book was written to bridge the gap between the many excellent ones on soil science and on the culture of vegetables. It is primarily for home gardeners, the largest group of tillers of the soil, that they may take advantage of the findings of soil science and of recent advances in knowledge of plant nutrition; that they may not be misled by pseudo science and half-baked theories masquerading under the name of science, which have been promoted by some who are sincere but misguided and by others with ulterior motives. There is no doubt that in these objectives he has been successful.

The first chapter, under the title of The Soils That Feed Us, is a popular description of soils, their characteristics and adaptation. This includes briefly the formation of soil, what constitutes a soil, the different kinds and groups of soil, where they are found, and the uses to which they are adapted. Such terms as mineral soils, organic soils, loam, soil series, and soil types are made clear to the lay person. While many successful gardeners have not had this background information, such knowledge should add greatly to the success and pleasure of gardening.

In the second chapter Garden Soils and Sites are discussed in detail, to show that adaptability includes workability as well as fertility. Criteria for garden soils are treated under the heads of texture, structure, profile, drainage, chemical composition, organic matter, stoniness, and topography. Recommendations for selecting the garden site are based on the fact that the garden becomes an intimate thing, and that much more is expected of it than a similar area in a farm field. While it may be desirable to have the garden in one's back yard or near by, the family automobile makes it possible, and perhaps more practical, to select a more favorable site a mile or more away.

Succeeding chapters treat soil fertility, improvement of garden soils, the use of organic matter and fertilizers, and tillage. Conservation of garden soils and the use

of conservation practices run throughout the discussion. One chapter is devoted to compost for home gardens. It treats the making, use, and application of compost; also the addition of inorganic fertility amendments and reagents to hasten decomposition, as well as the micro-organisms which bring about decomposition. While the use of compost and other organic fertilizers is highly recommended, their use to the exclusion of chemical fertilizers is shown to be a fallacy. The purchase and planting of earthworms is condemned. It is shown that if the soil has sufficient organic matter, the earthworm population will take care of itself. Up-to-date information on weed killers, hormones, and other plant growth regulators is supplied. Much valuable advice on various matters is included throughout the book. The last paragraph of each chapter summarizes the things to be remembered.

The last chapter is devoted to a discussion of soil, vegetables, and health. It treats of the much discussed prevalence and increase of degenerative diseases due to lack of important minerals and vitamins in the food we eat. The chemical composition of vegetables and other plants reflects the chemical composition of the soil on which they are grown. Plants of same appearance may vary widely in nutritive value, some having form without substance, producing "hidden hunger." The way to supplement a poor soil with needed minerals, and balance fertility, is to add the minerals in the form of commercial fertilizers. The author ridicules the tirades of certain groups and individuals against the alleged harmful, even poisonous, effects of commercial fertilizers acting through feeds and foods on animal and human health.

—WILLIAM W. REITZ, *Upper Darby, Pa.*

LAND ASSOCIATIONS AND PROBLEMS IN THE UINTA COUNTRY. *By* WESLEY CARR CALEF. *University of Chicago. 173 pp. Figures 23. Biblio. 1948.*

The Uinta Country lies in northeastern Utah. It is an area of about 6,500 square miles, of which less than 2,000 can be said to be inhabited. The people in the core of the area however, extend their operations out over the remaining area. No railroads enter the area, but it is bisected by Highway U. S. 40.

The natural vegetation holds a considerable interest. Over ninety percent of the area is still clothed with the original native vegetation and is the foundation of the grazing industry. Not quite 20 percent of the land is privately owned: the balance is in some form of public ownership; Indian lands 12%; Public Domain 39%; National Forests 21%; State and County lands 9%. Only a small part of the area is under irrigation; that which is not is utilized for range.

The author describes the grazing practices on the lands in various types of ownership, and points out the variations existing between the various permit systems employed in the area. He shows that in the Uinta Country, meat production was achieved at the expense of a rapid depletion of the range. With overgrazing came forage depletion and widespread erosion. Under the operation of the Taylor Grazing Act, the rate of deterioration has been slowed but not enough either to halt erosion or to increase the carrying capacity of the range. Now widespread water and wind erosion exists. Although there have been efforts to control this erosion, and the erosion rate is not increasing, it is problematical whether it has been slowed down.

The associated water problems are as pressing as those of the soil. Water supplies are limited. Problems arise that affect irrigation, farmstead practices, city water, and range supplies. Most serious are those of late season supply growing out of the fact that spring flood peaks are wasted. However, the best sites are already utilized and additional storage will be expensive especially when the low productivity of the lands is considered.

The author discusses several methods of solving the social and economic problems of the area. The first is to halt the deterioration of the natural resource base. Soil deterioration must be checked, both on the irrigated areas as well as on the open range.

Other aids lie in the reallocation of range rights to the public lands, the development of better roads, and more stable policies with reference to Indian lands. One big unknown is the possibility of using Green River water, but such use can only be brought about through large irrigation undertakings, publicly financed. Even then, the factor of isolation will remain a handicap.

The paper is of more than usual significance from two standpoints. First, one who has no axe to grind in the problem of management of public lands, comes out flatly in favor of retaining and extending controls of grazing use because without such controls man cannot restore the basic resource of the area—the range. Second, the author points out that if the region is to succeed economically, the range must be restored. Whether the author knows of the recent advances in range reseeding is not brought out, but it is possible that through some form of reseeding, much of the land can be restored. The basic faults in this area are the same as those which extend over a vast area of the western range lands. Reseeding alone will not do the trick. It will be necessary to reduce range use to its capacity, and then to manage it properly. Only by so doing will we be able to heal the scars of a century of abuse and keep the soil on the land and out of the streams.

—E. N. MUNNS, *Washington, D. C.*

"MY LAND AND YOUR LAND"—*Children's Conservation Series. National Wildlife Federation, Washington, D. C. $1.75 per set.*

"Would You Like to Have Lived When" for children in the third to fifth grades. This is a graphic, interesting tale of what our forefathers found here when our country was young. Virgin forests and soil, pure, clear lakes and rivers, wildlife of all species in abundance greeted the early settlers. It paints the picture of our expanding country. Cutting down forests to make farm land, plowing up the prairie for more farm land, killing off much of nature's store house of wildlife made problems for the generations of people who followed these pioneers in the frontiers.

"Raindrops and Muddy Rivers" for children in the fourth to sixth grades. In this booklet the student is shown in simple words, pictures and examples how dependent all life is on pure, clean water. The interrelationship of water, soil and life is a story of absorbing interest. Drought, erosion, and floods mean either too much or too little water. The wise control and use of our streams, lakes and other waters are pointed out by illustration which prints in the mind of the student the morals to be learned.

"Plants and Animals Live Together" for children in the fifth to seventh grades. Plants are the only natural food factories. All animal life, including man, is dependent upon them in one form or another. This intricate relationship is beautifully told and brings into the mind of the student the need for careful management of these bountiful warehouses of nature.

"Nature's Bank—The Soil" for children in the sixth to eighth grades. Step by step through the first three books, the authors have brought to the students the story of water, forests, plants and animals, and the value and importance of each in our own life. Nature's bank is the richest and the oldest bank in the world. How to extract these riches without robbing the bank is the theme of this book.

The Farmer and Wildlife. *By* DURWARD L. ALLEN. *Wildlife Management Institute, Washington, D. C. 1949.*

Here is an attractive bulletin of 84 pages on the management of farm wildlife that should serve an excellent educational purpose. It will be of use, also, to those who want to improve their lands for game, furbearers, and other wildlife. The booklet is illustrated with many photographs and humorous line drawings.

Geomorphology — *The Evolution of The Landscape. By* NORMAN E. HINDS. *Prentice Hall, Inc., New York. 1943. 839 pages.*

This book tells how the face of the earth has come to look as it does today. It tells also of some of the facial changes which have occurred during the long past. It is writen as an introduction to landscape evolution. The book is planned for the student and the general reader uninitiated in earth love. Abundant illustrations supplement the text and constitute a most important part of the book.

Soil, Food and Health. *By* JONATHAN FORMAN *and* O. E. FINK. *Friends of The Land, Columbus, Ohio. 1948. 342 pages. $4.50.*

Soil, Food and Health is a record of the National Nutrition Conferences held annually at Ohio University, Athens, Ohio. It includes papers by outstanding authorities on water, trees, soil, atomic energy, plants, farm animals and human nutrition. Each subject is well presented and properly related to soils, minerals, health, vigor and nutrition. The book deserves a large popular audience.

Grass Silage and Dairying. *By* RAY W. INRGAM *and others. Rutgers University Press, New Brunswick, New Jersey. 1949. 88 pages. $1.50.*

Conservationists and agricultural workers interested in grassland farming will welcome this book. It is based on a five-year research project carried on by the New Jersey Agricultural Experiment Station in cooperation with the Frasch Foundation for Chemical Research. The book presents the background of grass silage, dairy feeding today, production of grass silage and the returns that may be expected. Each subject is well organized and covers a field of interest that should appeal to professional workers as well as farmers.

Man on the Landscape. *By* VERNON GILL CARTER. *National Wildlife Federation, Washington, D. C. 1949. 129 pages. $1.50.*

This is an important book. It is directed at the teacher and emphasizes its educational value. The author points out that if we are to survive, we must reach the agriculturist, the forester, the sportsman, the nature lover, and particularly the teacher and student of plant life. This is an imporant audience and if properly informed will do much to influence public opinion. Mr. Carter is Supervisor of Conservation in the public schools, Zanesville, Ohio.

The Territory of Alaska is the largest soil conservation district in the world. Largest in the continental United States is the Honopah Soil Conservation District in Nevada with 12,750,000 acres inside its boundaries.

FIELD NOTES AND COMMENTS

Oregon State Graduates First Student in Conservation Engineering

The first student to complete the soil and water option in agricultural engineering at Oregon State College graduated this summer.

He is Ivan A. Custer, now employed by the Soil Conservation Service at Richland, Oregon. Custer came to Oregon State College in 1947, following his discharge from the Navy because he was interested in getting a degree in agricultural engineering. His graduation marks a step forward under the revised agricultural engineering curriculum which was established two years ago.

The revised curriculum leads to the degree of Bachelor of Science in agricultural engineering granted by the school of engineering. Under this curriculum, it is necessary for a student to decide at the beginning of his junior year which of the three options he wishes to specialize in, namely soil and water, power and machinery, or farm structures.

Included in the agricultural engineering course work are classes in the basic sciences of engineering and in addition such advanced-civil engineering courses as structural analysis, reinforced concrete, hydraulics, and hydraulic machinery. In addition to these pertinent engineering courses, the student receives special instruction in soils, soil conservation engineering, irrigation engineering etc. Prior to submitting the new agricultural engineering curriculum to the college authorities for approval, it was thoroughly discussed with engineers of the Soil Conservation Service and the Bureau of Reclamation, and their suggestions and recommendations were incorporated in the new curriculum.

The Agricultural Engineering Department believes this combination of courses in Engineering and Agriculture qualifies the agricultural engineering graduate to better fill positions in soil conservation engineering work, including farm irrigation and drainage, than does the curriculum in any other branch of engineering.

Enrollment in the professional agricultural engineering curriculum has increased from 0 two years ago to 35 at the end of the 1948-49 school year.

—J. B. Rodgers, *Agricultural Engineering Department, Corvalis, Oregon*

Hydrologists to Meet in Brussels

The International Association of Hydrology, of which the American Geophysical Union is the American representative, will hold a meeting at Brussels, Belgium, in 1951. Among the several committees of the International Association, corresponding in general to the committees of the American Geophysical Union, is a new Temporary Committee on Land Erosion. As this is the first international meeting since the formation of this new committee, it is the desire of the officers of the Association to have this subject well represented by significant papers at the Brussels' meeting. The following is a brief specification prepared by the officers of the Association as a guide in the appraisal of potential papers:

(1) The paper presented should be of immediate interest to a Commission session audience; that is, it should convey its message without too great dependence on mathematical derivations, etc.

(2) The paper should contribute to international hydrologic knowledge even though it is based on national or individual experience.

(3) The paper should be provocative and stimulating without becoming an unsupported version of some traditional controversy.

(4) The paper should be able to sustain its eligibility for publication under the fire of criticism and discussion at the Assembly.

The scope of the Temporary Committee on Land Erosion has been defined as including the following subjects:

1. Prevailing geologic norms of land erosion in type land-forms under use—(a) under water action, (b) under wind action, (c) under mass movement.
2. Present stage of land erosion in such land-forms, by (a) water action, (b) wind action, (c) mass movement.
3. Dynamics of erosional processes by water from (a) rain splash, (b) overland-flow, (c) rill and gully erosion.
4. Dynamics of erosional processes by wind, (a) from air turbulence, (b) in wind tunnel studies.
5. Dynamics of mass movement by, (a) solifluxion (b) landslips, (c) mudflows.
6. Sedimentation as measures of erosion, in (a) density currents, (b) silting of reservoirs, (c) other deposition.

It has been requested that any members of the Association who are interested in presenting papers at this meeting or who know of others who should be solicited for papers, communicate with the Committee Secretary, Mr. Carl B. Brown, Soil Conservation Service, Washington 25, D. C.

Teaching The Teachers Conservation

We believe the youngsters in grade schools should have the story of conservation to give them greater respect for our natural resources when they become adults. That is why we have been working toward this end for the past six or seven years and making definite progress. However, teachers, like the rest of us, prefer to teach subjects they know something about and most of them have had little training in conservation. Some means of giving this training stood out as one important problem in connection with the teaching of conservation in the schools.

In the fall of 1945 a proposed training program in conservation for in-service teachers was worked out in cooperation with M. E. Fonda who at that time was Head, Educational Relations Section in the Milwaukee office of Soil Conservation Service. This program was approved by the State Soil Conservation Advisory Committee which felt it should be in charge of the State Superintendent of Public Instruction. Later, in conference with the Advisory Committee, State Superintendent V. L. Nickell gave his approval. In March, 1946 he called together a committee to head up the program with Robert M. Ring, one of his assistants, as chairman. This committee included representatives of the five teachers' colleges, University of Illinois Division of Extension, Soil Conservation Service, Extension Service, State Departments of Agriculture and Conservation, Natural History Survey, State Museum, Illinois Federation of Sportsmen's Clubs, and Cook County Forest Preserve.

A suggested outline for a one-week training course in conservation was worked out by the committee. It included instruction in soil conservation, water resources, wild life, forest and woodlands, and minerals. In practice about two days of the week have been devoted to soil conservation and the remaining time has been divided among the other subjects. All of the teachers' colleges and the University of Illinois have cooperated in offering the courses which are given out in the counties. The county superintendent of schools makes all local arrangements for a particular course and the instructor in charge is responsible for presenting the instructional material. A common pattern has been to hold an indoor forenoon session of lectures, discussions, and movies and an afternoon trip to see actual examples in the field. The instructors have leaned heavily on farm advisers, conservationists, extension specialists, and soil conservation district directors for assistance with the field trips and to some extent with the lectures.

College Credit Given

Any teacher or student of college level, any graduate of a recognized four-year high school, or any in-service teacher may enroll. College credit is given for successful completion of the course; the amount being left to the institution offering it. In general one semester hour of

Figure 1.—School teachers in Ogle County, Illinois, learn the story of pasture improvement from a conservationist.

credit is given for a one-week course. There is a tendency to vary from the original program and extend the course beyond one week. One teachers' college now gives a three-week workshop each year. Another is offering several two-week courses. Still another has divided the course into two parts with soil conservation in one and wildlife, forestry, water, and minerals in the other. A schedule of courses for each division of the program was set up and held last year. This year courses will be given at the same locations, when the other portion of the program will be presented. For the longer courses correspondingly more credit is given. For example, the three-week workshop carries four quarter hours of credit.

How has it worked out? Seventeen courses were held in 1946 with a total enrollment of nearly 500 teachers. Fifteen courses were held in 1947 with 415 enrolled. In 1948, a total of 998 teachers were enrolled in 31 courses. Thus in the three years nearly 2,000 teachers have received the training. This year 41 courses have been scheduled which should further swell the number trained.

That teachers like the courses and appreciate the opportunity of finding out about conservation is indicated by their comments of which the following are typical:

"The course has truly been an 'eye opener' and a revelation to me in many ways. The idea of conservation had been very vague to me before; but I feel that if I can give to others as much as I have learned I will have really acomplished something worth-while."

"Having always lived and taught in town nearly everything said here was new to me—an inspiration and a great source of information and help in my work this fall."

No actual check or survey has been made as to the use which teachers have made of the training. We know from instances here and there which come to our attention that many are doing a good job. The courses have definitely stimulated the interest of county school superintendents and they are including conservation material in curriculum guides, putting conservation questions in examinations, and encouraging essay and scrapbook contests. Recently about 40 county and city superintendents spent an entire week attending a conservation course held for them by the State Department of Conservation.

Two publications have been prepared and issued in cooperation with the State Superintendent of Public Instruction as an aid to the program. A handbook for elementary teachers, *"Conserving Our Soil Resources,"* issued four years ago, has been well received. Just recently a second booklet, *"This Is Our Soil,"* has come off the press. It is well illustrated and is intended for use by the pupils.

With these and other publications available and with a large group of teachers who have a definite understanding of conservation, we believe we are getting in position to make real strides in giving this training to our young people.

—ERNEST D. WALKER, *Extension Soil Conservationist, Urbana, Illinois.*

Conservation Rotations Increase Efficiency of Applied Nitrogen

The several benefits to be derived from the use of a soil conserving rotation often fail to mention the fact that a good rotation makes the applied fertilizers more efficient. During the past six years a large number of crop rotations have been under study at the Southern Piedmont Conservation Experiment Station at Watkinsville, Georgia. These rotation studies are on Class II, III and IV land, representing gently sloping, moderately rolling, and steep slopes, respectively.

The fertilization schedule is uniform for each crop. Each year of a rotation receives an average annual application of 40 pounds per acre P_2O_5 and 30 pounds per acre K_2O, which is equivalent to 500 pounds per acre of 0-8-6 commercial fertilizer per year. Corn, cotton and oats receive nitrogen in addition. Cotton receives 500 pounds of 6-8-6 per acre and 100 pounds per acre of nitrate of soda side dressing. Thus the cotton receives 46 pounds of nitrogen.

The several rotations contain close-growing ground covers in varying proportions. These covers are either left on the surface or plowed into the soil. They supply organic matter which makes the soil open, porous, and more absorptive to water; improves the aeration; adds nitrogen; and increases the efficiency of the applied nitrogen.

The pounds of seed cotton produced in 5 different rotations on Class II and III land per pound of nitrogen applied, based on 5-year average (1944-48), is given in Table 1.

On Class II land, continuous cotton produced 21.4 pounds of seed cotton per pound of nitrogen applied in the fertilizer. The 2-year rotation produced 24.5 pounds. The 4-year rotation, which contains about the proper amount of close-growing ground cover to adequately protect soils in this class of land, produced 27.2 pounds of seed cotton for each pound of applied nitrogen. This represents an increase of 27 percent in yield over that of continuous cotton. The 4-year rotation is averaging about a bale of cotton per acre on Class II land.

On class III land, about one-half the topsoil has

Table 1. Seed cotton produced[1] per pound of nitrogen applied.

	Class of Land	
	II	III
	Pounds	
Continuous cotton	21.4	19.4
2-Year Rotation #10:		
(1) Cotton—vetch	24.5	23.5
(2) Corn crotalaria		
4-Year Rotation #20:		
(1) Oats (seed)—Kobe lespedeza (seed)		
(2) Kobe lespedeza (hay)		
(3) Cotton—vetch	27.2	24.9
(4) Corn—Oats		
3-Year Rotation #14:		
(1) Oats (seed)—Kobe lespedeza (seed)		
(2) Kobe lespedeza (hay)		
(3) Cotton—Oats	----	26.4
4-Year Rotation #28:		
(1) Oats-Caley peas (seed)—Kobe lespedeza (seed)—Caley peas		
(2) Caley peas (hay)—Kobe lespedeza (hay)—Caley peas		
(3) Caley peas (green manure)—corn-crotalaria—Caley peas		
(4) Caley peas (green manure)—cotton—oats-Caley peas	----	26.8

[1]The average yield of seed cotton may be determined by multiplying the above figure by 46, which is the total pounds of nitrogen applied. Seed cotton yields, for example, ranged around 25 × 46 = 1,150 pounds, or approximately .9 bale per half acre of lint cotton.

eroded away. A larger proportion of close-growing cover is required to adequately protect the soils in this class of land. The same rotations which provided good protection and produced good yields on Class II land are inadequate on Class III land. Cotton grown continuously produced 19.1 pounds of seed cotton per pound of applied nitrogen. Both the 2-year and the 4-year rotations gave increased yields of cotton. However the 3-year rotation is the only rotation on this class of land which, according to runoff and soil loss measurements, is supplying adequate protection. This 3-year rotation is producing about a bale of cotton per acre, or 36 percent more cotton than under the continuous-cotton method.

Crop rotations should include a sufficient proportion of close-growing cover crops to protect the soil from the churning action of falling raindrops and the scouring action of running water. Also, each rotation should include sufficient legumes and crop residues to manure the land well, and make it produce larger yields while reducing soil and water wastage. The average annual amount of legume residue in tops (dry weight) varied from none with continuous cotton, to .50 ton per acre with 2-year rotation No. 10, and .70 ton per acre with 4-year rotation No. 20. The 3-year rotation No. 14 also produced .70 ton per acre of legume residue. This rotation does not have two row crops in succession and is more conserving of the organic matter. The 4-year rotation No. 28 produced an average of 1.25 tons per acre of dry leguminous residues. These figures indicate that as the amount of plant manures is increased, the efficiency of the applied nitrogen is increased.

Organic matter makes the soil open and porous. It is under such conditions that plants produce a good root system. A good root system makes it possible for plants to utilize applied fertilizers to best advantage. The sensible and most practical way for the average Southern Piedmont farmer to secure higher efficiency from the use of the nitrogen he applies as fertilizer, is to utilize proven conservation methods for the production of his crops.

—WILLIAM E. ADAMS, *Watkinsville, Georgia.*

Figure 1.—Cotton makes more efficient utilization of the nitrogen in the fertilizer when grown in a good soil conserving rotation.

Report from United Nations

(*Continued from page 167*)

a. New methods of collecting water data (4 papers)
b. Analysis and utilization of data (7 papers)
c. Research in artificial precipitation (2 papers)

2. Water supply and pollution problems
   a. Utilization of surface, underground and sea water (3 papers)
   b. Control and utilization of polluted waters (5 papers)
3. Comprehensive river basin development—A symposium (6 papers)
4. Drainage basin management
   a. Water control through watershed management (5 papers)
   b. Effects of watershed management on water yields (3 papers)
5. Water control structures
   a. Water control structures (7 papers)
   b. Use of models in planning water control works (5 papers)
   c. Special water control techniques (5 papers)
6. Flood control and navigation
   a. Flood control (2 papers)
   b. Navigation (2 papers)
7. Irrigation and drainage
   a. Soils and water control programs (5 papers)
   b. Recent developments in irrigation (7 papers)
   c. Drainage of land for production (2 papers)
8. Hydro power and other water uses
   a. Hydro power and conservation (4 papers)
   b. Recreation use of water (1 paper)
   c. Protection of fish and wildlife (4 papers)

Post-conference field study trip. Immediately following the conference at Lake Success, approximately 150 delegates participated in a six-day field trip with stops at Pittsburgh, Pennsylvania; Columbus, Ohio; Decatur, Alabama; Chattanooga, Tennessee; Knoxville, Tennessee; and Washington, D. C.

The second land use capability map for an entire state is soon to be off the press. This map covers the State of Washington. The Kansas map was earlier, and the first of its kind. Both maps were prepared by the Soil Conservation Service.

Better Examples Are Needed

To The Editor:

I appreciate your efforts to make a good magazine for us. You have done especially well in filling the conservationists requirement of information in a wide area of technical subjects.

A short quote, on page 84 of Volume 4, Number 2, from a speech by Rev. L. H. Hass before the 1948 meeting of the Society in Cincinnati, attracted my unfavorable attention. His statement is based on two false assumptions: that the decline of the Israelitish nation was the result of land decline, and that the once beautiful Nile Valley is now a land of dry and drifting sands and impoverished people.

The history of the Israelites indicates that they became unrighteous and invading conquerors, desiring their good land, took them captive. Since then, the invadors have evidently let the land deteriorate. His second misstatement is refuted on page 58 of the same issue of the JOURNAL, where a short, statistical article on Egypt's population growth says Egypt is perhaps the most densely populated country in the world.

As scientific men we shouldn't expose our profession to the harm that may result from our condoning the liberal use of truth by others. By some additional study, better examples to illustrate the point in question could have been found.

—JUSTIN M. SMITH, *Columbia, Missouri*

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (39 U.S.C. 233)

Of JOURNAL OF SOIL AND WATER CONSERVATION, published quarterly at Baltimore, Maryland, for October, 1949.

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Soil Conservation Society of America, 3110 Elm Ave., Baltimore 11, Md.

Editor, Walter C. Gumbel, Watson Bldg., Fairmont, W. Va.

Business manager, Alvin C. Watson, Upper Darby, Penna.

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Soil Conservation Society of America, Inc. (no stock issued).

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

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5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the twelve months preceding the date shown above was (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

JOHN FERGUSON, 3D, *Publisher*

Sworn to and subscribed before me this 23d day of September, 1949.

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(My commission expires 5/2/1950)

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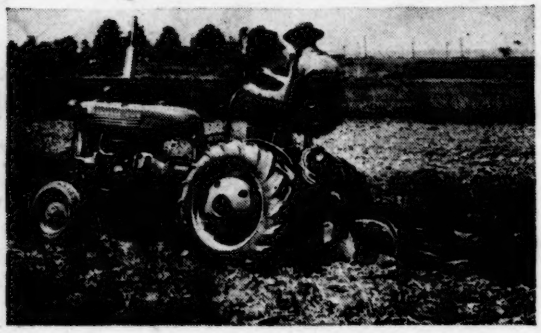

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